NOTABLE GENIUS IN PNEUMATICS

James Clerk Maxwell, about 1870, from a portrait formerly in the possession of Miss F. K. Dunn

NOTABLE GENIUS IN PNEUMATICS

CONTENTS

1. Albert Einstein on James Clerk Maxwell 1
2. Buckminster Fuller's Floating Cities 3
3. Historical Account of Mechanical Uses of Air (Thorkelson) 4
4. The Boy Who Discovered Compressed Air 6
5. Amory Lovins on Compressed Air 9
6. from *Reminiscences of Herman Haupt* (personal sketch by F. A. Flower) 1901 10
7. Excerpts from *That Man Haupt* 14
8. Articles on John Keely 18

Ideas and Opinions. Albert Einstein.
transl. Sonja Bargmann.
(NY: Crown, 1954). p. 266-270

MAXWELL'S INFLUENCE ON THE EVOLUTION OF THE IDEA OF PHYSICAL REALITY

On the one hundredth anniversary of Maxwell's birth. Published, 1931, in James Clerk Maxwell: A Commemoration Volume, *Cambridge University Press.*

The belief in an external world independent of the perceiving subject is the basis of all natural science. Since, however, sense perception only gives information of this external world or of "physical reality" indirectly, we can only grasp the latter by speculative means. It follows from this that our notions of physical reality can never be final. We must always be ready to change these notions—that is to say, the axiomatic basis of physics—in order to do justice to perceived facts in the most perfect way logically. Actually a glance at the development of physics shows that it has undergone far-reaching changes in the course of time.

The greatest change in the axiomatic basis of physics—in other words, of our conception of the structure of reality—since Newton laid the foundation of theoretical physics was brought about by Faraday's and Maxwell's work on electromagnetic phenomena. We will try in what follows to make this clearer, keeping both earlier and later developments in sight.

According to Newton's system, physical reality is characterized by the concepts of space, time, material point, and force (reciprocal action of material points). Physical events, in Newton's view, are to be regarded as the motions, governed by fixed laws, of material points in space. The material point is our only mode of representing reality when dealing with changes taking place in it, the solitary representative of the real, in so far as the real is capable of change. Perceptible bodies are obviously responsible for the concept of the material point; people conceived it as an analogue of mobile bodies, stripping these of the characteristics of extension, form, orientation in space, and all "inward" qualities, leaving only inertia and translation and adding the concept of force. The material bodies, which had led psychologically to our formation of the concept of the "material point," had now themselves to be regarded as systems of material points. It should be noted that this theoretical scheme is in essence an atomistic and mechanistic one. All happenings were to be interpreted purely mechanically—that is to say, simply as motions of material points according to Newton's law of motion.

The most unsatisfactory side of this system (apart from the difficulties involved in the concept of "absolute space" which have been raised once more quite recently) lay in its description of light, which Newton also conceived, in accordance with his system, as composed of material points. Even at that time the question, What in that case becomes of the material points of which light is composed, when the light is absorbed?, was already a burning one. Moreover, it is unsatisfactory in any case to introduce into the discussion material points of quite a different sort, which had to be postulated for the purpose of representing ponderable matter and light respectively. Later on, electrical corpuscles were added to these, making a third kind, again with completely different characteristics. It was, further, a fundamental weakness that the forces of reciprocal action, by which events are determined, had to be assumed hypothetically in a perfectly arbitrary way. Yet this conception of the real accomplished much: how came it that people felt themselves impelled to forsake it?

In order to put his system into mathematical form at all, Newton had to devise the concept of differential quotients and propound the laws of motion in the form of total differential

the turn of the century the conception of the electromagnetic field as an ultimate entity had been generally accepted and serious thinkers had abandoned the belief in the justification, or the possibility, of a mechanical explanation of Maxwell's equations. Before long they were, on the contrary, actually trying to explain material points and their inertia on field theory lines with the help of Maxwell's theory, an attempt which did not, however, meet with complete success.

Neglecting the important *individual* results which Maxwell's life-work produced in important departments of physics, and concentrating on the changes wrought by him in our conception of the nature of physical reality, we may say this: before Maxwell people conceived of physical reality—in so far as it is supposed to represent events in nature—as material points, whose changes consist exclusively of motions, which are subject to total differential equations. After Maxwell they conceived physical reality as represented by continuous fields, not mechanically explicable, which are subject to partial differential equations. This change in the conception of reality is the most profound and fruitful one that has come to physics since Newton; but it has at the same time to be admitted that the program has by no means been completely carried out yet. The successful systems of physics which have been evolved since rather represent compromises between these two schemes, which for that very reason bear a provisional, logically incomplete character, although they may have achieved great advances in certain particulars.

The first of these that calls for mention is Lorentz's theory of electrons, in which the field and the electrical corpuscles appear side by side as elements of equal value for the comprehension of reality. Next come the special and general theories of relativity, which, though based entirely on ideas connected with the field-theory, have so far been unable to avoid the independent introduction of material points and total differential equations.

The last and most successful creation of theoretical physics, namely quantum-mechanics, differs fundamentally from both the schemes which we will for the sake of brevity call the Newtonian and the Maxwellian. For the quantities which figure in its laws make no claim to describe physical reality itself, but only

equations—perhaps the greatest advance in thought that a single individual was ever privileged to make. Partial differential equations were not necessary for this purpose, nor did Newton make any systematic use of them; but they were necessary for the formulation of the mechanics of deformable bodies; this is connected with the fact that in these problems the question of *how* bodies are supposed to be constructed out of material points was of no importance to begin with.

Thus the partial differential equation entered theoretical physics as a handmaid, but has gradually become mistress. This began in the nineteenth century when the wave-theory of light established itself under the pressure of observed fact. Light in empty space was explained as a matter of vibrations of the ether, and it seemed idle at that stage, of course, to look upon the latter as a conglomeration of material points. Here for the first time the partial differential equation appeared as the natural expression of the primary realities of physics. In a particular department of theoretical physics the continuous field thus appeared side by side with the material point as the representative of physical reality. This dualism remains even today, disturbing as it must be to every orderly mind.

If the idea of physical reality had ceased to be purely atomic, it still remained for the time being purely *mechanistic;* people still tried to explain all events as the motion of inert masses; indeed no other way of looking at things seemed conceivable. Then came the great change, which will be associated for all time with the names of Faraday, Maxwell, and Hertz. The lion's share in this revolution fell to Maxwell. He showed that the whole of what was then known about light and electromagnetic phenomena was expressed in his well-known double system of differential equations, in which the electric and the magnetic fields appear as the dependent variables. Maxwell did, indeed, try to explain, or justify, these equations by the intellectual construction of a mechanical model.

But he made use of several such constructions at the same time and took none of them really seriously, so that the equations alone appeared as the essential thing and the field strengths as the ultimate entities, not to be reduced to anything else. By the *probabilities* of the occurrence of a physical reality that we have in view. Dirac, to whom, in my opinion, we owe the most perfect exposition, logically, of this theory, rightly points out that it would probably be difficult, for example, to give a theoretical description of a photon such as would give enough information to enable one to decide whether it will pass a polarizer placed (obliquely) in its way or not.

I am still inclined to the view that physicists will not in the long run content themselves with that sort of indirect description of the real, even if the theory can eventually be adapted to the postulate of general relativity in a satisfactory manner. We shall then, I feel sure, have to return to the attempt to carry out the program which may be described properly as the Maxwellian—namely, the description of physical reality in terms of fields which satisfy partial differential equations without singularities.

R. Buckminster Fuller, St. Martin's Press, 1981, NY

In 1958 I saw clearly the progression of technical events altering all old engineering concepts regarding the relative increase in the overall weights of structures—and designed my sky-floating tensegrity structures, which I call "Cloud Nines."

A 100-foot-diameter, tensegrity-trussed, geodesic sphere weighing three tons encloses seven tons of air. The air-to-structural-weight ratio is two to one. When we double the size so that the geodesic sphere is 200 feet in diameter, the weight of the structure increases to seven tons while the weight of the air increases to fifty-six tons—the air-to-structure ratio changes as eight to one. When we double the size again to a 400-foot geodesic sphere—the size of several geodesic domes now operating—the weight of the air inside increases to about 500 tons while the weight of the structure increases to fifteen tons. The air-weight-to-structure-weight ratio is now thirty-three to one. When we get to a geodesic sphere one-half mile in diameter, the weight of the structure itself becomes of relatively negligible magnitude, for the ratio is approximately a thousand to one.

When the Sun shines on an open-frame aluminum geodesic sphere of one-half-mile diameter, the Sun penetrating through the frame and reflected from the aluminum members of the concave far side bounces back into the sphere and gradually heats the interior atmosphere to a mild degree. When the interior temperature of the sphere rises only one degree Fahrenheit, the weight of the air pushed out of the sphere is greater than the weight of the spherical-frame geodesic structure. This means that the total weight of the interior air plus the weight of the structure is much less than the surrounding atmosphere. This means that the total assemblage of the geodesic sphere and its contained air will have to float outwardly, into the sky, being displaced by the heavy atmosphere around it.

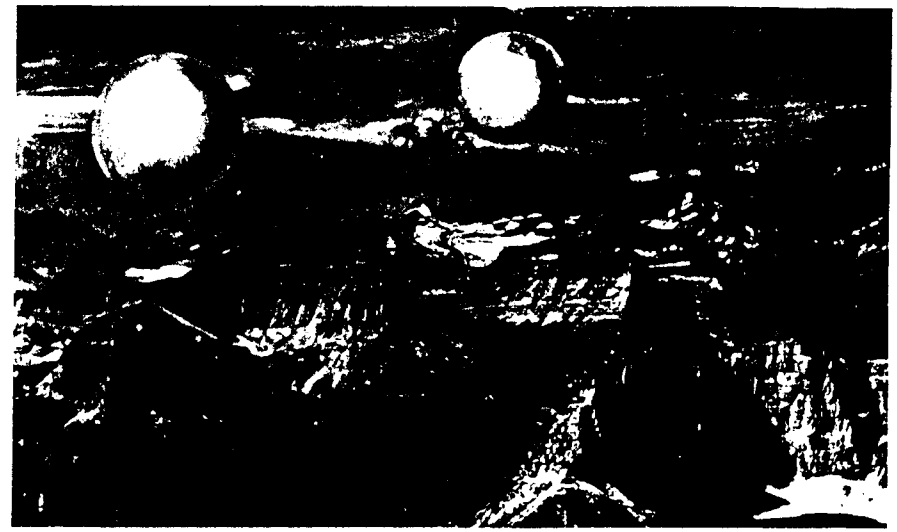
When a great bank of mist lies in a valley in the morning and the Sun shines upon it, the Sun heats the air inside the bank of mist. The heated air expands and therefore pushes some of itself outside the mist bank. The total assembly of the mist bank weighs less than the atmosphere surrounding it, and the mist bank floats aloft into the sky. Thus are clouds manufactured. As geodesic spheres get larger than one-half mile in diameter, they become floatable cloud structures.

If their surfaces were draped with outwardly hung polyethelene curtains to retard the rate at which air would come back in at night, the sphere and its internal atmosphere would continue to be so light as to remain aloft.

Such sky-floating geodesic/tensegrity spheres may be designed to float at preferred altitudes of thousands of feet. The weight of human beings added to such prefabricated "Cloud Nines" would be relatively negligible. Many thousands of passengers could be housed aboard one-mile-diameter and larger cloud structures. The passengers could come and go from cloud to cloud, or cloud to ground, as the clouds float around the Earth or are anchored to mountaintops.

While the building of such floating clouds is some years in the future, we may foresee that, with the floating tetrahedronal cities; air-deliverable skyscrapers; submarine islands; sub-dry-surface dwellings; domed-over cities; flyable dwelling machines; and rentable, autonomous-living, black boxes, man may be able to converge and deploy around Earth without its depletion.

FIGURE 52. Cloud Nine Floating Tensegrity Spheres



In the United States, throughout all twenty-four hours of every day of the year—year after year—we have an average of two million automobiles standing in front of red stoplights with their engines going, the energy for which amounts to that generated by the full efforts of 200 million horses being completely wasted as they jump up and down going nowhere.

Air Compression & Transmission
H.J. Thurkelson
NY: McGraw-Hill 1913

INTRODUCTION

HISTORICAL ACCOUNT OF MECHANICAL USES OF AIR

The earliest writings describing mechanical uses of air are found in a book entitled "Pneumatics" by Hero of Alexandria, published about 200 B. C. An English translation of this by Bennet Woodcroft indicates a very complete knowledge of many mechanical devices possessed by the Ancients, and shows various pumps, Hero's steam turbine and many remarkable uses of air as a means of transmitting energy.

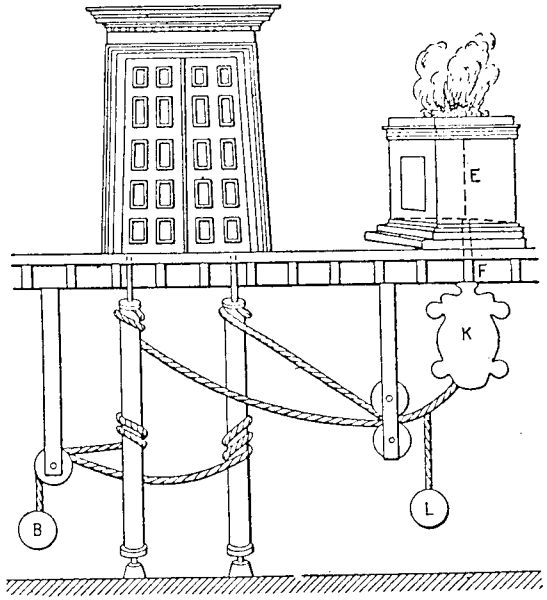


FIG. 1.—Hero's device for opening temple doors.

One of the most interesting illustrations is a device for opening temple doors by fire on an altar illustrated in Fig. 1. The altar, *E* is hollow and a tube *F* passes through the altar and is attached to a leather bag, *K*. Beneath this a small weight *L* is suspended which is connected to the bag and to the pivots of the temple doors as shown. Weights *L* and *B* are so proportioned as to normally

close the doors. When a fire is lighted on the altar, the bag *K* will expand under the pressure of the heated air below the altar and, in doing so lift the weight *L*. Weight *B* then falls and causes the doors to open. If the fire is extinguished, the air under the altar will cool, contract, and the bag *K* will take the position indicated and weight *B* will be dropped, causing the doors to close.

A somewhat similar device is also described in the same text using heated air under a similar altar to force water from one chamber into a pail, thus counterbalancing the weight and causing the temple doors to open. Many automatons are also described, in which air is made use of to produce musical notes and cause water to flow from vessels or objects when certain changes in the mechanism take place.

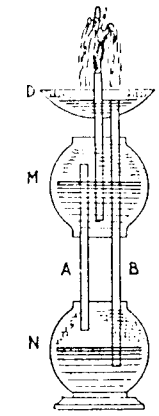


FIG. 2.—Hero's fountain.

A very interesting experiment, illustrated in most texts on physics, called "Hero's Fountain" and invented by the author of the book "Pneumatics," consists of two globes, Fig 2, *M* and *N*, and a brass dish, *D*. The dish *D* communicates with the lower part of the globe *N* by a tube *B* and another tube *A* connects the two globes. A third tube passes through the dish *D* to the lower part of the globe *M*. This tube having been taken out, the globe *M* is partially filled with water, the tube is then replaced and water is poured into the dish. The water flows through the tube *B* into the lower globe and expels the air which is forced into the upper globe. The air being compressed acts upon the water and makes it jet out as shown. If it were not for the resistance of the atmosphere and friction, the liquid would rise to a height above the water in the dish equal to the difference of the level of the water between the two globes.

Although a knowledge of this wonderful method of transmitting energy has been known for centuries, it is only within comparatively recent years that it has been used to any considerable extent in practical work. Its modern use dates from the construction of the Mt. Cenis tunnel completed in 1871. The work on this tunnel, which is about 8 miles long, had progressed very slowly from 1857 to 1861, the tunnel headings having been drilled by hand labor with an average advance in each of the two headings of about 1 1/2 ft. per day. Machine drills driven by compressed air were introduced and the speed rose to 4 3/4 ft. per day, and later when dynamite was

introduced, the cut was increased to 6 ft. per day. Sommeiller deserves the honor for solving, in this work, many of the initial problems of compressed-air production and use. The type of compressor used is illustrated in Fig. 3. A natural supply of water was used for compressing the air. The water was conducted in a sluice *A* through a valve *C*, compressing the air which is in *D* and forcing it into the reservoir *E*. When this was done the valve *C* was automatically closed and the water in *D* allowed to escape and be replaced by a new supply of air at atmospheric pressure. This

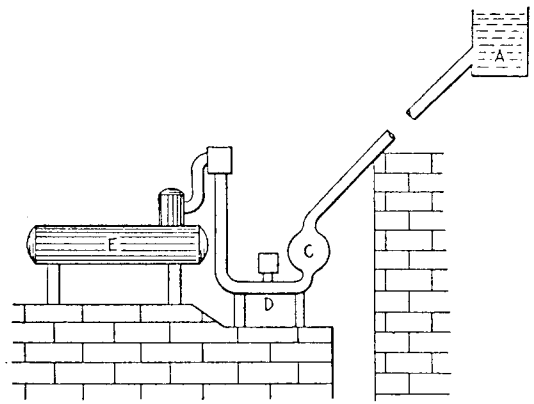


FIG. 3.—Sommeiller's compressor.

was in turn compressed and forced into the reservoir *E*, giving not a continuous but an intermittent flow of air. This compressor furnished air at 80-lb. pressure, but only gave an efficiency of 50 per cent., that is, only one-half of the available energy was turned into useful work.

Although the value of compressed air for machine drills for tunnel work was clearly demonstrated in the building of Mt. Cenis tunnel, it was some time before this was applied to mining work. One of the earliest tests for mining work was made at the Calumet and Hecla copper mine in Michigan in 1878, and the advantages in lower costs and higher speeds were so clearly demonstrated that its use for this work has since become almost universal.

One of the most important of modern applications of compressed air is to be found in the braking of trains. George Westinghouse, in 1869, designed his first "straight air brake," which was later changed to the "automatic" type of air brake. This apparatus has

been improved and perfected to such an extent that its operation is truly marvelous and its application world wide.

Railroad men were among the first to appreciate the uses of compressed air in shop and structural work, and its application to manufacture and other allied arts has since become so universal that a mere recital of the modern applications of compressed air would become tedious. One of the largest manufacturers of air compressors has recently published a partial list of various applications of compressed air for which they have furnished compressors. This list includes over sixty different industries, with a great many different uses of compressed air in each.

While compressed air has many advantages over other systems of transmitting energy, it has also certain disadvantages and limitations which should be clearly understood. In order to appreciate these, it is necessary to study in detail the nature and characteristics of air and the fundamental principles governing its generation, distribution, and application.

THE STORY OF MECHANICS

The Story of Captive Force or Development of Machine Power in This Industrial Age

By
A. RUSSELL BOND
Former Managing Editor, Scientific American

With Additions by
ALBERT A. HOPKINS
Associate Editor, Scientific American

Revised by
A. P. PECK
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P. F. COLLIER & SON CORPORATION
PUBLISHERS 1948 NEW YORK

AIR VS. WATER

THE steam engine had its origin in a kitchen; the pendulum clock was first conceived in a cathedral; our laws of motion were discovered under an apple tree, but, strangest of all, pneumatic engineering had its beginning in a *barber shop*. In each case it was an inquisitive boy who played the leading rôle.

We do not hear much about the youthful father of pneumatic engineering, possibly because he lived so very long ago, but his story is fully as interesting as that of Watt or Galileo or Newton. Young Ctesibius dwelt in the city of Alexandria, Egypt, 250 years before the birth of Christ. His father kept a barber shop, and the young lad used to watch his father practice his tonsorial art on the Greek and Egyptian dandies of the time. No doubt Ctesibius's father expected to make a first-rate barber of his son, but history does not tell us much about his early life.

The barbers of those days had their mirrors as do the barbers of the present time. But a mirror in those days was a treasured possession. It consisted of a brightly polished plate of metal in which a person could see himself "darkly"—or it might have been a plate of glass with a black backing. These mirrors had to be carefully preserved from injury and from moisture, and so, instead of having them mounted on the wall as in a modern barber shop, they were stowed carefully away and brought out only after the tonsorial artist had completed his operation and was ready to exhibit his finished product to the customer.

THE BOY WHO DISCOVERED COMPRESSED AIR

Now in the tonsorial parlors of Ctesibius's father the precious mirror was suspended above the head of the customer and when the barber had finished the shave or haircut he pulled down the mirror and let the customer survey his remodeled countenance. After the customer had viewed himself to his heart's content the barber merely released the mirror and it was automatically drawn back into place by a counterweight that slid in a case fastened to the wall. Young Ctesibius noticed that every time the mirror was released a curious whistling sound came from the case in which the counterweight moved. No doubt this phenomenon had been recurring day after day for years, but it excited no more curiosity than would a squeaky door, until, one day, the barber's son happened to notice it. Immediately he was all curiosity. No one knew anything about air in those days and the boy could get no satisfactory explanation of the phenomenon, so he started an investigation of his own. He found that the counterweight fitted very closely in its case and when it dropped it forced a stream of "wind" out of a crevice which produced a whistling sound. That set Master Ctesibius to thinking. He had discovered a method of harnessing the wind. No more barber shop for him; he was launched upon a career of scientific research and invention.

The first use he made of his discovery was to build a pipe organ which was driven by a water wheel and hence was known as a water organ. But there were other and more lucrative fields for the newly discovered power. Being invisible, compressed air proved a most valuable medium for performing seemingly miraculous tricks with which the corrupt priesthood of that time hoodwinked the public. Naturally such air-controlled apparatus was kept secret, and we have only a meager record of a few of the ingenious devices used in the temples. However, Ctesibius made many scientific discoveries and became the most famous mathematician and scientist of his age. We have read in Chapter IV of his famous clock that recorded hours of varying length according to season.

While Ctesibius is credited with being the first man to make scientific use of compressed air, the use of free air or wind as a power far antedates him. Sailing vessels were probably in use long before windmills were invented. As pointed out elsewhere, windmills possessed an advantage over water wheels in that they could be placed anywhere, instead of being confined to the banks of streams. They were widely used for pumping water, grinding grain, and sawing wood until the steam engine arrived and displaced them.

Although wind power is but little used today, air is much more widely used in modern machinery than is

generally realized. A catalogue of the various devices in which it plays a prominent part is likely to prove astonishing. For instance, we employ it to bore through rock, to stop the speeding express train, and even to quell ocean billows. Being elastic and compressible, it makes an ideal spring for the storage of power and a cushion for absorbing shocks. It is also used to fight back water and permit men to work in the depths of the sea or in water-bearing sand and earth.

Despite his extensive use of air Ctesibius knew nothing of the atmospheric pressure. It was not until the seventeenth century that atmospheric pressure was discovered and measured. It was then learned that there is no such thing as suction.

AIR SPRINGS AND CUSHIONS

UNLIKE water, air is a highly compressible, elastic fluid, and as such furnishes an excellent medium for the storage of energy. It acts just like a clock spring into which energy may be introduced and stored by winding or compressing the spring. The energy remains locked up in the spring and when the spring is released, it gives back just as much energy as was put into it, except for slight frictional and heat losses. Air is a much better spring than steel or any other metal because it never loses its elasticity from fatigue and because it has an enormous capacity for the storage of energy. It possesses one serious drawback, however. Much of the energy that is expended in compressing it is converted into heat. If the air were to be used immediately and without transmitting it to a distance, there would be no advantage in extracting the heat, but heat cannot be stored in air for long and it would gradually escape from the storage reservoir or air receiver and from the pipes leading the air to the machines that it was to operate. As the heat escaped it would lower the pressure of the air and hence much of the energy would be lost.

Heat of Compression

In Chapter V we described a hydraulic system of compressing air and noted that one of the advantages of this system is that it delivers air cooled to the temperature of the water. This, of course, does not mean that there is no loss due to heat. The air bubbles as they are compressed are cooled by the water that compresses them; in other words, the heat of compression passes off into the water, making the water warmer than it would otherwise be. Heat is not produced without expenditure of energy and a certain proportion of the resulting power is thus wasted.

In most cases air is compressed by steam or electrically driven compressors, and in such machines the heat due to compression is a serious matter. The air cylinders are water-jacketed to carry off the heat. But air is a poor conductor; it acquires heat faster than it can give it off to the water surrounding the cylinders. In compound air compressors the air compressed in one cylinder is cooled before being passed on to the next cylinder, where it is further compressed. The heat loss in compressing air in a single stage up to 100 pounds gauge pressure is about 30 per cent. The higher the initial heat of the air, the greater the rise of temperature. If a volume of air be subjected to 294 pounds gauge pressure, it will occupy about one-tenth of its former volume. If the air was introduced into the compressor at zero, it would acquire a temperature of about 650 degrees; if introduced at 60 degrees, it would show an increase of about 800 degrees; and, if started at 100 degrees, it would show an increase of 900 degrees in passing through the compressor. This shows the advantage of compressing the air in stages and cooling the air between stages.

Sometimes the heat developed is sufficient to produce a disastrous explosion. Air is noncombustible, but the oils used to lubricate the compressor are vaporized by the heat and when mixed with air form a powerful explosive. Care has to be taken that none but high-grade oil with a high flash point be used in the compressor and that the temperature of compression does not rise to near the flash point lest the vaporized oil be ignited.

That fire can be produced by sudden compression of air has long been known in the Philippine Islands. The natives use a small air tube with a close-fitting plunger as a fire maker. Combustible matter is placed in the bottom of the tube, and on striking the plunger a sharp blow this is ignited.

When compressed air is used in an air motor it expands and in so doing absorbs heat. The more rapidly it expands, the more heat it absorbs. This heat it extracts from the motor and from the atmosphere into which it escapes, and it is a common occurrence to find a thick coating of frost around the exhaust port. This is due to condensation of moisture in the atmosphere or in the compressed air itself, which, because of the rapid extraction of heat, is converted into snow. On cold days enough frost may be produced in the exhaust pipe to clog it and interrupt the operation of the motor, and frost sometimes clogs the air lines leading to the motor.

The fact that compressed air is cooled on expanding makes it an ideal power for use in mining machinery. Steam is inconvenient because of the difficulty of transmitting it to the machines without loss of heat, because it would heat the machines so that they could not be handled readily and because the exhaust would fill the mine with an impenetrable fog; electricity is dangerous in mines that are apt to contain explosive gases, because the wires are liable to be broken and cause sparks by short circuiting, and because sparks are likely to form between the brushes and commutators of the motors; but compressed air has none of these objections, and,

furthermore, the discharge from the machines furnishes the operators with ample supplies of fresh cool air which drives out disagreeable and dangerous gases.

Stopping Trains with Air

Air has played a most important part in transportation. When the air brake was first introduced its purpose was to prevent collisions and provide greater safety of operation. It was not generally realized that efficient air brakes are not only a safety precaution, but a means of increasing schedule speeds. The more quickly a train can stop, the better speed it may make, particularly on a schedule that calls for frequent stops.

In the first air brake invented by George Westinghouse, the locomotive was provided with a reservoir in which air was stored and compressed by means of a steam-operated air pump. The cars were each provided with a cylinder and piston connected to the air reservoir through a valve conveniently located in the engineer's cab. The piston of the air cylinder was connected with the air brakes so that whenever the engineer wished to stop his train he merely turned on the compressed air and all the brakes in the train were operated. This was a great saving over the previous system of providing brakemen to operate hand brakes.

Propelling Cars with Air

If air can be used to stop a train, why cannot air be used to propel it? This question occurred to many inventors and they answered it by building air-propelled cars and locomotives. Pneumatic cars were tried out on street railways, but they had to give way to electric cars which do not need to carry their power around with them, but can draw it from a central power plant through a trolley wire. In only a few situations, such as in mines where electric sparking is feared, are air-propelled cars and locomotives still used to any considerable extent.

However, air plays another and highly important part in transportation and here it is employed not to deliver energy stored in it, but to serve as a cushion. Without the soft, flexible grip of the air-filled rubber tires with which automobile wheels are shod, high-speed motoring would be practically impossible. There is nothing that can compare with air for absorbing shocks and unevennesses in the road. Whenever an obstruction is encountered, not only is the shock absorbed by elasticity of the air, but the impact is immediately distributed uniformly over the whole tire, so that the strain on the tire is not localized and the life of the tire is correspondingly increased. There have been many attempts to introduce substitutes for pneumatic tires, such as combinations of metallic springs and straps, but these have failed, chiefly for the reason that they cannot distribute the shock as the pneumatic tire does. Consequently they are not only liable to damage, but they do not absorb the obstructions as readily as the pneumatic tire and the vehicle which they carry is subjected to heavy stresses and strains.

Air as a cushion is used to prevent the rebound of the springs of an automobile and is also widely employed in machinery to absorb the momentum of moving parts or to slow the action of a spring. In a door check, for instance, a powerful spring is provided which would slam the door shut were it not for the cushioning action of air. A plunger is connected to the door and slides in a cylinder on the door frame. The air compressed by the plunger can escape only very slowly through a small port.

Air Cushions for Elevators

Air cushions are used in elevators to prevent too rapid a fall of the car in case of accident. The lower part of the elevator shaft is completely inclosed and fitted with steel doors to form an air pocket. The car fits the shaft closely enough to compress the air under it when it is moving downward. At normal speeds, this air escapes quite readily around the sides of the car and through cracks in the doors, but when the speed is excessive the air cannot escape fast enough and sufficient pressure is built up to retard the car so that it will strike the bottom with a moderate impact not at all dangerous to the passengers.

In the Woolworth Building, New York, the highest elevator shafts are 680 feet high and the air pockets are 137 feet deep—i. e., they reach up to the tenth story. If the car broke away from its supports at the top of the shaft it would be traveling at the rate of 132 miles an hour when it struck the air pocket, but before it reached the bottom the air would bring it practically to a stop. Imagine a heavy automobile traveling at 132 miles per hour and brought down to a standstill in half a city block! The passengers would be hurled out of their seats, but in an elevator the passengers are standing and can brace themselves against the pressure produced by their own momentum. The velocity acquired in falling 543 feet to the air pocket must be overcome in 137 feet or ¼ of the distance. This means that the weight of each passenger is multiplied by four. A man who weighed 150 pounds would find that his pressure on the floor of the car had mounted to 600 pounds. One of the inventors of the pneumatic cushion for elevators was killed when testing out a car, not because of the impact of the car, but because he was foolish enough to sit in a chair. The chair gave way under his suddenly acquired weight and the poor man was fatally stabbed by one of the splinters.

Air as a Tension Spring

So far we have been considering air as a compression spring. It may also be employed in a manner somewhat

analogous to a tension spring. When air is exhausted from a receptacle we have a partial vacuum which will produce work, but in the opposite direction from that produced by compressed air. Of course there is no such thing as suction, and it is the pressure of the atmosphere which is employed to do the work.

In 1869 Alfred E. Beach built an experimental subway line under Broadway, New York, near Warren Street. The line was only 200 feet long. A cylindrical car, large enough to hold eighteen people, fitted the bore snugly and was propelled in one direction by compressing the air in the tunnel and in the other direction by exhausting the air.

The Ultracentrifuge

A tiny air-driven turbine driving a rotor in a partial vacuum is the basis of the ultracentrifuge, a new research tool with which physicists and chemists may study the effects of extreme pressures on various organic and inorganic substances. The rotor revolves at a speed of 1,250,000 revolutions per minute, developing a maximum centrifugal force of 8,000,000 times gravity. The turbine is so designed and balanced that it develops this tremendous speed on an air pressure of only 15 pounds per square inch. It takes over thirty minutes to reach top speed, and a similar length of time to stop.

THE MOTHER EARTH NEWS®

NOVEMBER/DECEMBER 1977

PLOWBOY: Perhaps you could explain what you mean by that . . . by matching "energy quality" to end-use needs. What does that mean?

LOVINS: Well as you know, energy comes in many different forms, some of which are what a scientist would call "low grade" energy. That isn't a derogatory term . . . it just means that the kind of energy in question—low-temperature heat, usually—can't do difficult kinds of work. Now, there's an awful lot of low-grade energy around. There's more low-grade energy in the Atlantic Ocean, for instance, than there is high-grade energy in all the oil in the Middle East, but you can't do much with it.

By matching energy quality to end use needs, I simply mean that where you have a job that can be done by low-grade energy, you should use low-grade energy to do that job, and not high-grade energy.

PLOWBOY: Is there much of a need for low-grade energy in this country?

LOVINS: Oh yes. About half of all the energy needed in the U.S. today is required in the form of heat at temperatures below a few hundred degrees Celsius. Altogether something like 58% of our end-use needs are for heat. And only a fraction of that 58% is high-temperature heat.

PLOWBOY: How do you answer critics who say that energy storage is a major problem with soft technologies?

LOVINS: I think they've got it backwards. Energy storage is a major problem with hard technologies. It's a minor problem with soft technologies. The reason for this is that with soft technologies, you aren't trying to electrify everything or store large amounts of energy. You would instead be trying—where you needed storage—to store energy at the point of end use, in rather small amounts, and often at rather low quality. Now it's very simple to store low-temperature heat . . . you can do it in water or rocks. There might be more elegant ways to do it, but you don't need them.

Again, let's go through the kinds of energy we're talking about. Low- and high-temperature heat would be stored *as heat*, at the point of end use. That's easy. Liquid fuels would be stored as liquid fuels. That's easy . . . we're already doing it. Electricity would be stored as water behind existing dams. We're already doing that too. That's all there is, except maybe for mechanical energy, which you can always store as compressed air.

PLOWBOY: Compressed air? That's not very practical, is it?

LOVINS: I think it is. Some European cities—Paris and Vienna, for example—used to offer compressed air as a standard utility. It ran all the motors in those towns until the turn of the century, when electricity took over. Compressed air is actually a very highly developed technology. I recently looked in the Yellow Pages of the phone book in a large American city, under the heading "Compressed Air", and there were something like six pages of listings!

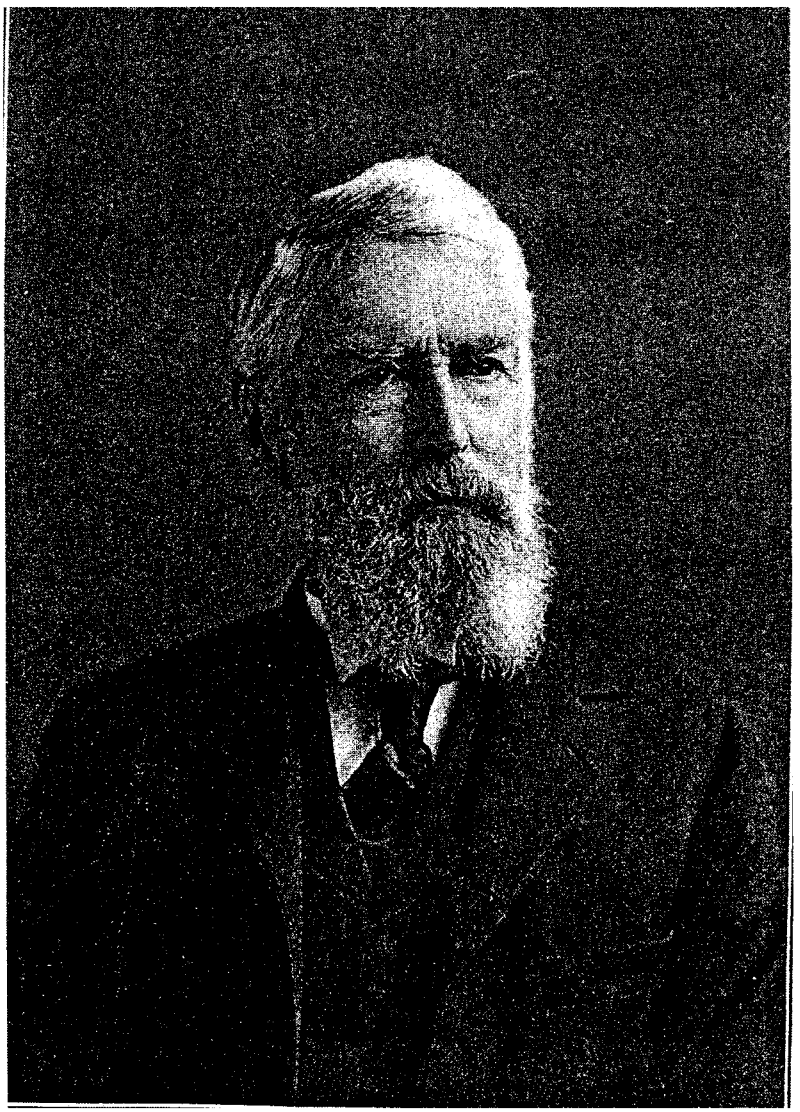
Compressed air is very handy stuff. It's exceedingly simple and reliable. It's spark-proof, which—of course—is why it's used so much in mining. And it has good torqueing characteristics . . . air-powered wrenches are used, for example, in car assembly. Of course, it's also used there because if the workers were to steal the tools and take them home, they wouldn't be able to use them.

Anyway, I think compressed air has been much underrated as an energy carrier.

Amory Lovins (Director of Research), a consultant experimental physicist, was educated at Harvard and Oxford. He holds an Oxford MA and five honorary doctorates, has taught at many universities, and has been active in energy policy in more than 15 countries. A Fellow of the American Association for the Advancement of Science and former member of the Department of Energy's senior advisory board, he has published a dozen books and over 100 papers. His energy consultancy to many national, state, and local governments and to private firms has made him, in *Newsweek's* terms, "one of the Western world's most influential energy thinkers." He and Hunter shared a 1982 Mitchell Prize and a 1983 Right Livelihood Award (often called the " alternative Nobel Prize").

[photos by Doug Child]

Herman Haupt at the age of 84.



General Haupt was the original air car advocate.

REMINISCENCES

OF

GENERAL HERMAN HAUPT

Director, Chief Engineer and General Superintendent of the Pennsylvania Railroad
Contractor and Chief Engineer for the Hoosac Tunnel
Chief of the Bureau of United States Military Railroads in the Civil War
Chief Engineer of the Tidewater Pipeline
General Manager of the Richmond & Danville and Northern Pacific Railroads
President American Air Power Company
Etc Etc

GIVING

HITHERTO UNPUBLISHED OFFICIAL ORDERS,

PERSONAL NARRATIVES OF IMPORTANT MILITARY OPERATIONS,

AND

INTERVIEWS WITH PRESIDENT LINCOLN, SECRETARY STANTON, GENERAL-IN-CHIEF HALLECK, AND WITH GENERALS MCDOWELL, MCCLELLAN, MEADE, HANCOCK, BURNSIDE, AND OTHERS IN COMMAND OF THE ARMIES IN THE FIELD, AND HIS IMPRESSIONS OF THESE MEN

[WRITTEN BY HIMSELF]

WITH NOTES AND A PERSONAL SKETCH BY
FRANK ABIAL FLOWER

Illustrated from Photographs of Actual Operations in the Field

1901

GENERAL HERMAN HAUPT.

GENERAL HAUPT, now in his 85th year and the active head of an important manufacturing enterprise in the United States, is one of the most interesting, as he certainly is one of the most remarkable, figures in our history.

Few men have participated in so much that has contributed to the growth and grandeur of our country, yet how little the world knows of his career, how reluctant the trumpeters have been to herald his achievements!

A designer and builder of roads and bridges; a constructor of railroads and tunnels; a professor and author; an inventor and master mechanic; a military strategist and civil counsellor; a railway manager and canal engineer; a manufacturer and organizer of great enterprises; a military and civil engineer, still up-to-date and a leader of progress, he links the old with the new, the slow and sleepy past with the swift and dashing present in a way that is entirely exceptional.

He was born in Philadelphia on March 26, 1817. His father, Jacob Haupt, died in 1828, leaving a widow and six children.

WEST POINT COMMISSION DATED AHEAD.

In 1830, through the help of John B. Steriger, Member of Congress from Pennsylvania, he received an appointment to West Point from President Andrew Jackson; but as he was only 13, the commission was dated a year ahead. He entered in June, 1831, at the age of 14, and graduated in 1835, at the age of 18, in a class with General George G. Meade and others who became distinguished in the civil war.

Of that early class of fifty-six members, there are no survivors except General Haupt, and in the entire list of graduates of the United States Military Academy the only senior is General Thomas A. Morris (1834) of Indianapolis, Ind.

In the fall of 1835 he resigned his commission in the army to

Finally he secured permission from the County Commissioners of Baltimore to lay his line on a county bridge, high over the tracks, thus defeating the railroad and reaching tidewater in safety.

Without the power of eminent domain to condemn rights-of-way for hundreds of miles through the property of those recalcitrant holders who are encountered in every great enterprise, and surrounded and watched everywhere by the hostile agents of the most powerful corporations in the United States, Haupt's pipe-line achievement stands as one of the most remarkable feats of its character in this country, and is the one in which, perhaps, he takes the greatest pride.

The Tidewater Pipeline, which Haupt's success rendered possible, is now, as it has been for many years, in successful operation, with offices on Broadway, New York, and is one of the decisive elements which combined to give cheap illuminating fluid to the people of the entire nation, while, at the same time, the members of its original enemy, the Standard Oil Company, have been able to accumulate fortunes that are really fabulous in size, due in part to the system of trunk pipe-lines like Haupt's now in general use under the general law subsequently passed.

In 1879 General Haupt was employed to examine and report upon Hardie's pneumatic motors, five of which were constructed and tested upon the Second Avenue Railroad in New York. A compression plant was erected in Harlem, from which air at a pressure of 360 pounds was introduced into cylinders placed under the car seats. The motors were entirely successful, but were never generally introduced.

Haupt demonstrated that the cost of transporting passengers by horse power, including general expenses and a 6 per cent. dividend, was 4.55 cents each, and by pneumatic motor 2.57 cents each.

Such a result was entirely revolutionary, but the projectors could not get their motors upon the roads.

In the same year (1879) General Haupt was appointed consulting engineer of the United States Hydrogen Company, a corporation engaged in developing processes for the anti-corrosive treatment of iron and steel. Many of the results were entirely satisfactory, and articles treated by these processes resisted even the attacks of aqua regia.

Reminiscences of General Herman Haupt

Limited Autograph Edition

Signed Herman Haupt

IN JULY, 1901.

resist acids.[60] When this news broke, the value of the company's stock tumbled drastically, Gill's patents became useless, and Haupt was left with a pocketful of worthless securities.[61]

In 1879 he also became interested in the use of compressed air for streetcar motors. He was asked to examine and make a report on a new compressed-air motor invented by Robert Hardie, a Scotch engineer, and constructed by the Pneumatic Tramway Company. Hardie had built five motors in 1878 and arranged for the Second Avenue Railroad in New York City to test their reliability and performance in daily traffic. Haupt was asked to observe the operation and to estimate the costs of conversion to compressed air for existing streetcar companies and the costs of constructing new systems run exclusively on compressed air.[62]

Haupt had investigated the manufacture and uses of compressed air while working on his rock drill and at that time had not been impressed. But in his report of February, 1879, he was enthusiastic over the possibilities offered by Hardie's motor for urban transportation. He watched the tests over a period of several months and concluded that if there was a very small rise in the number of passengers, the road could make a satisfactory profit while charging only 2.5 cents per ticket.[63]

Despite the projected savings resulting from the use of compressed air, the horse car companies refused to consider adoption of the idea because, as Haupt stated later, "Public opinion was not sufficiently educated to regard this improvement with favor. Absurd as the objection then made may now appear, presidents of horse rail road companies declared . . . that the system could not be used without stuffing the skins of dead horses and running them on a low truck in front."[64] But this was not the only reason for the failure of the system. A group of promoters formed a dummy company to manufacture and sell the motors. These men capitalized the firm at one million dollars and appropriated the stock themselves without payment, an unlawful transaction. To evade the illegalities, the patents on the motors were given a value of a million dollars and purchased from Hardie for a stock consideration in the

60 Lewis Haupt to Herman Haupt, November 30, 1883, in Letterbook II, 472; Lewis Haupt to Herman Haupt, November 30, 1883, *ibid.*, 495.
61 Lewis Haupt to Herman Haupt, November 30, 1883, in Letterbook II, 495.
62 Herman Haupt, *Street Railway Motors. . . .* (Philadelphia, 1893), 61.
63 Herman Haupt, "Compressed Air for Street-Cars," *The Engineering Magazine*, III (1892), 621.
64 New York *Sun*, March 28, 1897; Haupt, *Street Railway Motors*, 107–108.

company. The managers then hypothecated the patents for loans they were unable to pay, and when the company folded it also lost the patents.[65]

It is not known whether Haupt invested in this company, but he may have been involved in a small way, for when the compressed air company was reorganized in the 1890s, he owned some stock. He probably was involved in the original patent development, for he received a patent himself on an improved compressed-air motor in conjunction with George H. Reynolds, a New York City engineer.[66] Haupt never acknowledged any royalties, nor is there any evidence that his motor was actually tested. His reports confined themselves to an analysis of the Hardie motor.

During 1879, Haupt also examined a unique heating system developed by the Holly Steam Combination Company of Lockport, New York (the same firm that designed the pumping apparatus for the Tide Water Pipeline). He spent eight days in Lockport examining the heating plans devised by the company's engineer, Birdsill Holly.[67] Holly proposed to abolish the concept that an individual house have its own heating system and substitute in its place a neighborhood boiler room which provided steam heat through underground mains to all the houses. He envisioned a single steam station heating an area of one square mile, with the inhabitants of the houses being charged only for the amount of steam consumed, as indicated by a meter arrangement. The advantages of the system were numerous, for the problems of cellar boiler explosions, ash disposal, kindling fires, and drafty houses would be eliminated. Moreover, the steam could be utilized to heat stoves. Holly's steam stove eliminated the need for pots and pans as the food was merely dumped into a compartmentalized top. After examining the entire system, Haupt calculated the size of the boilers, the resistance of long pipes to fluids, and the comparative costs of the central system against individual furnaces.[68] Holly had been undecided on whether to use hot water or steam, but Haupt found that the use of steam was more practical from the standpoint of efficiency and cost. Using it, a house could be heated for two hundred days at

65 Haupt, *Street Railway Motors*, 108–11.
66 *Annual Report of the Commissioner of Patents for the Year 1879* (Washington, D.C., 1880), 156.
67 Herman Haupt, *Report Upon the System of the Holly Steam Combination Company Limited, of Lockport, N.Y., for the Introduction of the District System of Heating for Cities and Villages*, (Lockport, N.Y., 1879), 11.
68 *Ibid.*, 25–32, 75–78.

a cost of only $29.12. When the same house was heated by an individual furnace, the cost rose to $110.00.[69]

Haupt concluded his report by looking to the future and predicted that utilization of refinements in compressed air and steam would have vast social as well as economic consequences. He looked forward to the day "when tenement houses, those hot-beds of vice, crime, and pestilence, shall be abandoned, and their unfortunate occupants removed to healthy suburban localities . . . where they can be brought to their work and returned to their homes by compressed air motors. . . . when three meals can be cooked and apartments warmed at a nominal cost by the Holly System, then a stride will be taken in the amelioration of the condition of the working classes. . . ."[70] He was realistic enough to believe, "I may not live to see the bright dreams of the future realized"; but he promised, "If capitalists will refrain from excessive charges, humanity will reap large benefits from these inventions."[71] Unfortunately, nobody reaped large benefits from the system, for it was never introduced. Less than a year later, Haupt entered into what was undoubtedly the most visionary scheme of his career. By 1880 he had been carrying the burden of paying taxes on the Chambers property for eleven years, trying desperately to make Mt. Lake at least pay expenses. He finally concluded in 1880 that the hilly wooded lands were ideal for raising goats and, as with everything else he did, he entered the project head first and with great enthusiasm. On February 2, 1880, he incorporated the Virginia Angora Company with himself as president and his sons Lewis and Charles Edgar as directors.[72] Haupt had bought several herds of goats, but later found out the man he bought them from did not own the goats. Averse to a lawsuit, Haupt did not attempt to recover his money and wrote off the entire loss; the Virginia Angora Company slid into obscurity.[73]

This flight of fancy happily did not occupy much of Haupt's time in 1880. In that year he once again dusted off his plans for the improvement of the Ohio River and appealed to Congress for help. His interest in the Ohio River was reawakened in December, 1879, when at President Hayes' request he testified before the Ohio River Commission in Washington explaining his

69 Haupt, *Report Upon Holly Steam Combination*, 55–57, 65.
70 *Ibid.*, 78–79. 71 *Ibid.*, 79.
72 Charter for the Virginia Angora Company, Feburary 2, 1880, in Yale Haupt Papers, Box 20; Notice of board of directors meeting, March 1, 1880, *ibid.*, Box 7.
73 Chapman, "Haupt," Chap. IV, Pt. 5, p. 22. Chapman does not state how much money Haupt lost in this fiasco, but it was probably not much.

plans for improved navigation. His testimony and particularly the high projected cost drew criticism from proponents of other improvement schemes.[74]

On returning to Philadelphia Haupt revised his original plan of constricting the river channel to maintain a six-foot water level during the dry season. His chief improvement was to do away with the need for damming up tributary rivers as slackwaters. Instead he designed a device that could be sunk in the Ohio and would automatically rise when the speed of the current increased; holding the water back, it would create slackwaters in the Ohio itself. His innovation would not hinder navigation, as the bottoms of ships would slide over it. Haupt patented the first slackwater device in March, and an improved version in June, 1880.[75]

Haupt also rewrote his plans to incorporate his new invention and with the sponsorship of the Pittsburgh Chamber of Commerce he sent them to Congressman John H. Reagan, the chairman of the House Committee on Commerce, asking that they be considered for use by the Corps of Army Engineers. Haupt's plans were ordered printed and were considered by committees in both houses of Congress, but his price tag of twenty million dollars was too high. He again filed away the plans for future reference.[76]

Disappointed, Haupt turned back to urban transit problems and investigated one of the most novel elevated railway designs ever presented. Joseph V. Meigs of Boston had invented a system that consisted of a line of single steel poles with rails attached a short distance away from each side near the top. The cars which operated over this line had wheels angled toward the center at the bottom, with flanges that hooked on the inside of the rails giving stability and support.[77]

A short section of test line was constructed in Boston under the direction of Benjamin Butler, who had been a counsel for the Seaboard Pipeline. He asked Haupt to come up to Boston and appraise the feasibility of the novel

74 U.S. Congress, House, *Plans for the Improvement of the Ohio River. Petition of Herman Haupt and the Pittsburgh Chamber of Commerce, Praying for An Examination of Certain Plans for River Improvement*, 46th Cong., 2nd Sess., 1880, Misc. Doc. No. 33, pp. 1–2.
75 *Ibid.*, 2; *Annual Report of the Commissioner of Patents for the Year 1880* (Washington, D.C., 1881), 89; a copy of the March 2, 1880, patent is in Yale Haupt Papers, Box 19.
76 *Plans for Improvement of Ohio River, passim*; Chapman, "Haupt," Chap. IV, Pt. 4, pp. 44–47.
77 *Reports of Herman Haupt and James L. Meigs, Consulting Engineers on the Meigs Elevated Railroad, and Description of the Same by the Inventor* (Boston, 1881), *passim*.

ingly. Cecilia, their unmarried daughter, moved to Washington to help care for her mother and was in attendance when Anna Cecilia died on Saturday, April 11, 1891. By Monday all her children had arrived in Washington from Philadelphia, St. Paul, and Chicago; the following day the family accompanied Anna Cecilia's body to Philadelphia where she was buried in West Laurel Hill Cemetery.[14]

Anna Cecilia's death had an unexpected effect upon Haupt. Although grieved over the loss of his wife after an exceedingly harmonious and loving relationship of fifty-two years, he did not become morose or introspective. Rather, he once again became professionally active. Freed from worry about his wife's health, and perhaps bewilderingly lonely, he took up new interests, renewed old acquaintances, published his *Reminiscences*, made some investments, traveled again, and became a social commentator.

The engineer in Haupt reawakened first. In 1892, he had a chance meeting with Robert Hardie, the inventor of the compressed air motor upon which Haupt had reported in 1879. Hardie was now working as a mechanical engineer in preparation for the opening of the 1893 Columbian Exposition in Chicago.[15] Still an energetic promoter of his motors, Hardie imbued Haupt with some of his enthusiasm during a long technical discussion. Haupt unearthed the results of his 1879 experiments with Hardie's motor and wrote an article extolling its technical superiority and economy; the article was published in *Engineering Magazine*, in August, 1892.[16] After the publication of the article, Haupt spent the winter of 1892 examining the feasibility and the cost of adapting different types of motive power to streetcars. He summarized the results of his lengthy investigation in a book, *Street Railway Motors*, published in 1893. In it he predictably touted compressed air as the superior mode of urban transportation.[17]

The publication of his book did not diminish the popularity of electric streetcars, but it did persuade a group of men to form the General Compressed Air Company, hire Haupt as consulting engineer, and construct several full-size experimental motors in Rome, New York.[18] With a little

14 Death notice of Anna Cecilia from Herman Haupt to friends, April 17, 1891, in Hensel Family Papers.
15 New York *Sun*, March 28, 1897.
16 Herman Haupt, "Compressed Air for Street-Cars," *Engineering Magazine*, III (1892), 617–22.
17 Haupt, *Street Railway Motors*, 190.
18 New York *Sun*, March 28, 1897; notes made by Haupt, 1898, in Yale Haupt Papers, Box 18.

financial backing, Haupt began in earnest to instruct the public about the advantages of compressed air. His book was followed by a pamphlet published in March, 1894,[19] summarizing the conclusions in the book. Later in the year he published *Rapid Transit in New York*, an open letter to Abram S. Hewitt, ex-mayor of New York City and chairman of the Rapid Transit Commission.[20]

Haupt's open letter to Hewitt was prompted by the Rapid Transit Commission's debate over the construction of a subway system for the improvement of the rush hour traffic flow.[21] Haupt had failed to impress streetcar companies in Philadelphia with compressed air (probably because one of the companies was run by his old antagonist, Thomas Ackley), and he had also been unable to secure its adoption in Boston.[22] The debate in New York gave him a chance to popularize the concept of compressed air by broadcasting copies of his open letter and granting interviews to all willing newspapers.[23]

Late in 1895 Haupt wrote another long technical paper, *Long Distance Transmission of Power;* in it he attempted to strike at the source of cheap electricity by discrediting the plans to transmit it across New York state from the proposed hydro-electric power plant at Niagara Falls.[24] He corresponded with electrical engineers on the subject and concluded that electricity could only be transmitted cheaply if it was in the range of twenty thousand volts; beyond that point insulators broke down and expensive transformers were required.[25] Haupt proposed that the falls, instead of generating electricity, be used to operate air compressors. Using the formulas he had derived for the transmission of fluids through pipes for the Tide Water pipeline, he calculated that compressed air could be transmitted through pipes for distances of up to one hundred miles much more economically than electricity could cover the same distance through wires. He suggested that compressed

19 Herman Haupt, *Relative Cost of Steam, Compressed Air and Electricity for the Operation of Railroads* (Washington, D.C., March 23, 1894).
20 Herman Haupt, *Rapid Transit in New York. . . .* (Washington, D.C., 1894); Allan Nevins, *Abram S. Hewitt With Some Account of Peter Cooper* (New York, 1935), 470, 528.
21 Nevins, *Abram S. Hewitt*, 503.
22 Letterhead, Ackley to Haupt, March 18, 1880, in Yale Haupt Papers, Box 7.
23 Abram S. Hewitt to Haupt, November 13, 1893, in Haupt Papers, Minnesota Historical Society, Minneapolis; George B. Roberts to Haupt, December 11, 1894, *ibid.*; George S. Boutwell to Haupt, January 1, 1895, *ibid.*
24 Herman Haupt, *Long Distance Transmission of Power* (New York, 1895).
25 *Ibid.*, 4.

air could be transmitted to towns and used to operate local electrical generators.[26]

But Haupt was unable to slow down the growing popularity of the electric motor. Despite successful tests of the Rome compressed air motors on the 125th Street Elevated Railway and his publication of yet another article in the *Journal of the Franklin Institute* in 1897, New York City refused to adopt Haupt's plans. The general introduction of compressed air remained only a dream so long as no capital was forthcoming.[27] He purchased an unknown amount of stock in the General Compressed Air Company and served as its consulting engineer until the end of March, 1898. By then the company was in such poor financial condition that it could not even pay Haupt for his last four months of service. From November, 1897, until the end of March, 1898, he was also president of the American Air Power Company; his salary was five thousand dollars per year, but he never received a cent of it.[28] Neither of the compressed air companies was ever listed on any stock exchange.

While Haupt was occupied with his futile quest to promote the introduction of compressed air, he also developed a new interest: the problem of containing floods and preventing the buildup of sediment in the mouth of the lower Mississippi River. His attention had been drawn to these problems in 1892 when he attended the National Nicaragua Canal Convention in St. Louis as a delegate from Washington, D.C. The following year he was hired by the Lilienthal Brothers of New York City as a consulting engineer to examine the harbors along the coast of Texas.[29] In March of that year Haupt took a steamboat down the Ohio and Mississippi to Vicksburg, the home office of the old Southern Railroad. He wrote to Lewis, "I found my old friend Judge Marshall still living and very bright intellectually, but a wreck physically. . . . All the directors of the Company are dead and the country not much improved and not susceptible of improvement."[30] He continued to New Orleans and thence to Galveston, where he took notes on sediment

26 *Ibid.*, 21, 36.
27 Herman Haupt, "Compressed Air for City and Suburban Traction," *Journal of the Franklin Institute*, CXLIII (1897), 13–26, 119–32.
28 Notes made by Haupt, 1898, in Yale Haupt Papers, Box 18; Haupt to Ellen Haupt Chapman, November 10, 1896, *ibid.*, Box 9.
29 Appointment of Haupt as a delegate to National Nicaragua Canal Convention, May 27, 1892, in Yale Haupt Papers, Box 8; Haupt to Lilienthal Brothers, May 17, 1893, *ibid.*
30 Herman Haupt to Lewis Haupt, March 23, 1893, *ibid.*

deposits and other harbor conditions; he was back in New York City by early May to file his report.[31]

Haupt's interest in the Mississippi lay dormant for the next four years. But Lewis, a professor of civil engineering at the University of Pennsylvania, had been experimenting with a jetty which extended out from the mouth of a river to create a natural scour of the riverbed. This system was, he claimed, far superior to a twin jetty system proposed by the army engineers.[32]

In 1897, Haupt researched the problem of the buildup of sediment in the Mississippi and studied the remedy proposed by the Corps of Army Engineers and the Mississippi River Commission of high levees from Cairo, Illinois, to the Gulf. Haupt concluded that this reliance on levees neither protected the lower river from floods nor secured the desired scour. He pointed out in two articles published in the New York *Sun* in May and June, 1897, that scours were created by the slope of the riverbed and that the levees would only build up the deposits at the lower end of the river, reducing the slope and the scour along the entire route. Moreover, the levees would not protect against floods; as the river silted up, the levees would have to be heightened to compensate for the raised level of the riverbed.[33]

In a series of articles, Haupt made a counterproposal to the levee system.[34] He suggested small levees for local protection and the construction of outlets along the river to release surplus water in the spring. He proposed that Lakes Borgne and Pontchartrain and the Atchafalaya River be used as emergency outlets for the overflow. Moreover, small reservoirs could be constructed along the river, filled in the spring, and used for irrigation during the dry summer season. Much of the silt brought down in the spring would thus be channeled off into swampy lands, and a correct slope could be maintained within the river by dredging in the summer and fall.[35]

Haupt's plans were largely ignored, and he concentrated instead on finding a financial backer willing to finance a test of Lewis' jetty at the south pass of the Mississippi. Haupt visited Carnegie in 1902 and tried to interest him in the project, but received no definite commitment.[36] He renewed his

31 Haupt to Lilienthal Brothers, May 17, 1893, *ibid.*
32 Haupt to Carnegie, January 6, 1902, in Adamson Collection.
33 New York *Sun*, May 23 and June 8, 1897.
34 Herman Haupt, "The Problem of the Mississippi," *Journal of the Franklin Insitute*, CXLVII (1899), 297; Herman Haupt, "The Problem of the Mississippi," *Gulf Ports Marine Journal*, I (1902). This article was reprinted as a pamphlet in 1905.
35 Haupt, "The Problem of the Mississippi," pamphlet, 23–27.
36 Haupt to Carnegie, January 6, 1902, in Adamson Collection.

KEELY: PIONEER OF GRAVITY CONTROL

Keely lived one hundred years too soon. If he were alive today he would be the foremost leader in the field of acoustical levitation. NASA has only now begun to realize the potential of acoustical levitation in minor utility roles. Working alone in a then totally uncharted science one hundred years ago, Keely is outstanding.

He was working in the acoustical frequency range of what is generically called gravity control. What we call levitation or antigravity is really the control of gravity itself. There are many frequency ranges in the EM spectrum which have gravity control frequencies in them, but probably the easiest gravity control frequency range for the interested amateur to use (which is what Keely used) is the lowest major gravity standing wave section between 7.8 Hz and 60,000 Hz. At the low end of this first major gravity standing wave section is the audio frequency band in which Keely worked. The general frequencies that are gravity control in the audio frequency bandare 7.8 Hz, 73.5 Hz, 690 Hz, and 6,450 Hz. The ones at 7.8 Hz and 690 Hz are the strongest, with the ones at 73.5 Hz and 6,450 Hz usable with more power. Any good audio oscillator can generate the 690 Hz and 6,450 Hz sine-wave signals. Causing levitation is then only a matter of multiple speakers or transducers to radiate the signal properly arranged. The term "properly arranged" signal sources is a bit complex. Usually an arrangement of 6-8 or more signal sources (speakers, etc.) equidistant from the object to be levitated is required for gravity control. These multiple sources are equally spaced around the levitation object in 90 degree or 180 degree arrangements. The three critical factors are the signal feed-in angles, the signals phasing, and the proper power levels. Now you can appreciate all the problems and failures that Keely faced in his day. How he ever got it to work at all is amazing! But then again, the Tibetans levitate large rocks with these audio frequency methods using only drums and trumpets. I would venture a guess that the Tibetans use 73.5 Hz and 690 Hz with those particular musical instruments. The musical score for the Tibetan levitation must sound very strange to achieve the proper phasing and power criteria.

In summation, Keely was right about the prospects for levitation but regrettably he was one hundred years too early. A great deal of his work can be recovered if proper understanding of his peculiar vocabulary can be achieved. He was a pioneer of the first rank in real science. I am sure that in the years to come he and his works will receive the honor that they so greatly deserve.

Permission is given to anyone to publish all or any part of the above data.

Note: I am enclosing a copy of the Tibetan sound levitation method. Please do not publish my address. I do not wish to answer questions from readers.

Richard LeFors Clark, Ph.D.

Richard LeFors Clark, Ph.D.
April 22, 1986

p. 72-73

INVESTIGATIONS AT THE KEELY LABORATORY.

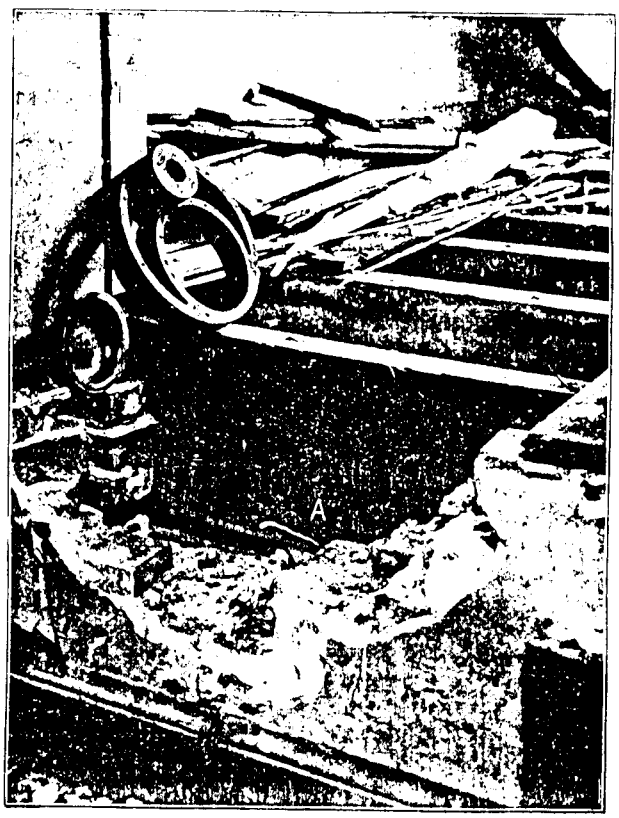
In our last issue we noted the fact that the Keely laboratory, at 1420 North Twentieth Street, Philadelphia, Pa., had been examined by experts, and that the discoveries seemed to confirm the views held by the SCIENTIFIC AMERICAN in 1884, that the phenomena were produced through the medium of compressed air. A representative of the SCIENTIFIC AMERICAN was at once sent to Philadelphia, and through the courtesy of Mr. Clarence B. Moore, who has the lease of the premises, unique photographs and diagrams were obtained.

The laboratory is an inconspicuous brick building two stories in height. After Mr. Keely's death the laboratory was given up, and all the apparatus, wires, tubing, etc., in fact, everything which could be used as a clew to the discovery of the principles underlying the alleged motor, but it is shown by the result that Keely had not taken anyone into his confidence, and accounts for even his supporters being ignorant of the existence of the remarkable things which we are to describe.

The investigations were carried out under the auspices of the Philadelphia Press.

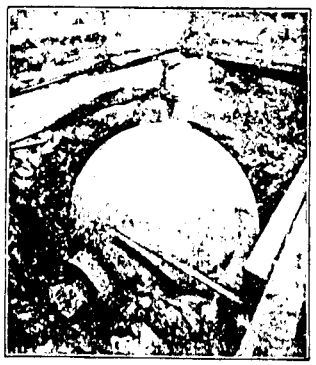
Every bit of flooring was ripped up and every nook and cranny explored in the floors, walls, and ceilings, and it was found that the building was honeycombed with traps, holes for piping, etc., for carrying on the bogus experiments. Everything was conducted with such secrecy and ceremony, and the laboratory lent itself so admirably to the purposes of deception, that it is little wonder that this nineteenth century thaumaturgist should have been successful, for the border line between science and quackery is always attractive.

The ground floor has no cellar under it and at places the joists were sawn away and the flooring had been removed and replaced in sections, forming what is known in stage parlance as "traps." Most of the spaces between the sawed joists were filled with ashes, and here valuable finds of tubing and connections were made. The center room contains four traps and a pit. Back of this was a room to which no one was ever admitted, and here a remarkable discovery was made. A steel sphere forty inches in diameter, weighing 6,625 pounds, was found embedded in a pit underneath a trap. The sphere had two projections or trunnions: both had a hole through them; one of these holes had been filled up and then faced off, and the other, near the iron pipe shown in our small illustration, was open and was of the proper size for charging the reservoir. Midway between the two trunnions a small hole drilled into the side of the sphere was found to be the proper size for connecting with one of the small brass tubes connecting with the second story. These tubes, while of small diameter and having a small bore, have very thick walls, showing that they could resist enormous pressure. Of course, the sphere possessed great strength and must have been an ideal storage reservoir for air or gas at a great pressure. William Rickert, who was formerly employed in Keely's laboratory, has come forward with valuable evidence. He says he helped to test the steel sphere with a hydraulic pump which was specially made for the purpose. It was tested up to 28,000 pounds, or only one ton less than the powder chamber pressure required in tests of United States ordnance. Steel tubes were also tested with this powerful hydraulic pump. The tubes were 9 inches in diameter and the bore was only 3 inches. These were split with enormous pressure and the stockholders and the general public believed that the tubes were burst by the "etheric vapor." Mr. Rickert states that they ran tubes to the lever machine which indicated pressure, and one of the tubes recently discovered Mr. Rickert believes to be a tube running to that machine. He also states that Keely never allowed the men to entirely complete any connection to the machinery; he assumed that part of the business himself. A very heavy iron pipe with high pressure joints, 13½ feet long, ran diagonally under the floor to a point in a trap in the front room. This was undoubtedly used in distributing the compressed air. The room where the sphere was discovered had a wooden ceiling nailed on to the joists, while in the front room the joists were exposed. This ceiling gave 16 inches of space, which, of course, gave an excellent opportunity for running tubes or concealing apparatus. The private room in the rear was used by Mr. Keely when resting from his arduous labors and was handsomely fitted up.



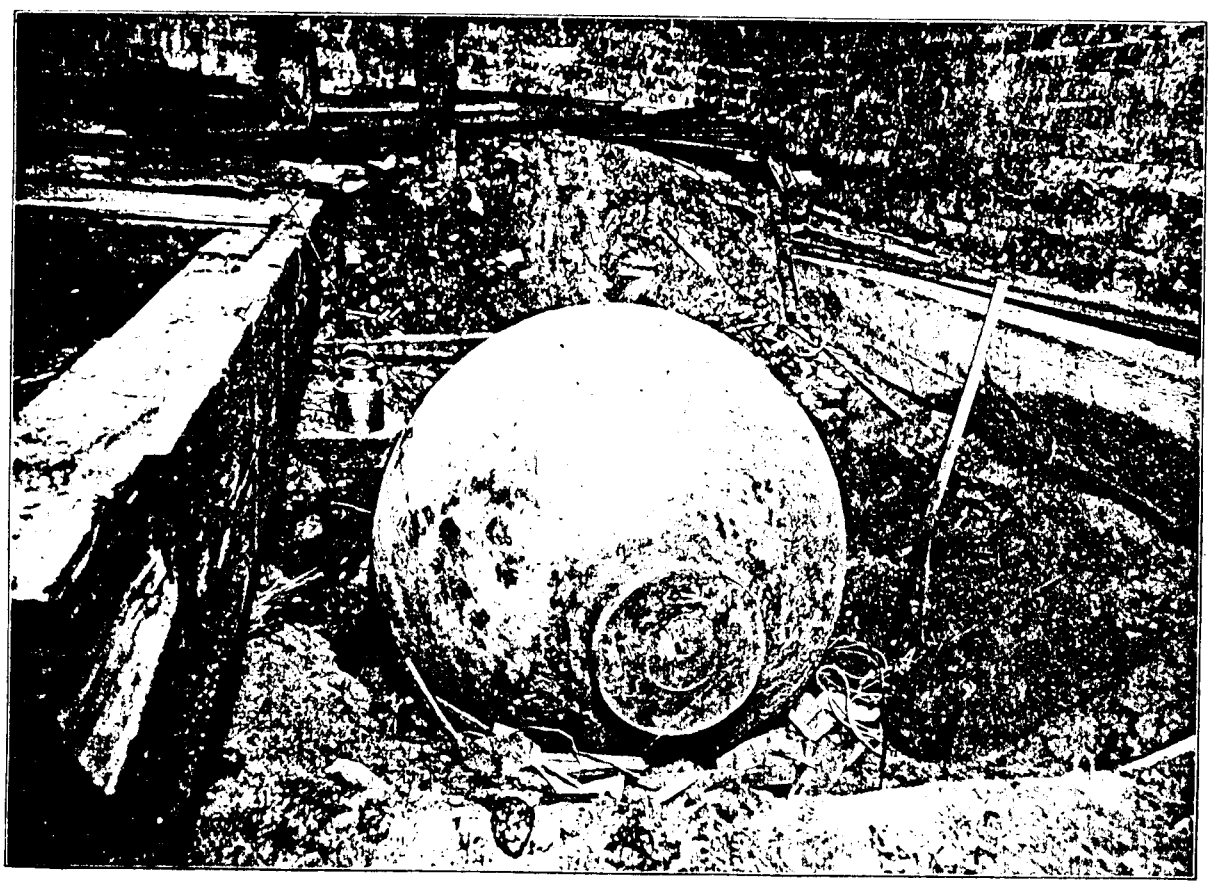
Threshold of Rear Exhibition Room, Showing Concealed Tube, A.

The second floor was divided into an office and two exhibition rooms, where progress was reported at intervals. Sometimes the front exhibition room was used, but generally the rear exhibition room was utilized. A small window connected the exhibition rooms and also the office. Keely would station himself behind the small window, *C*, connecting the exhibition rooms, and after asking the favored few who were allowed to see the manifestations what pressure they desired or what speed they wished, depending upon the nature of the apparatus which he was then exhibiting, he would then play a violin, a zither, or a harmonica to set in motion the harmonic vibrations upon which he depended for obtaining his remarkable manifestations. The first exhibition room has many auger holes, which have been indicated by our artist. These holes were, of course, hidden by the oilcloth which covered the floor, and one of the holes was covered with a piece of tin with a hole cut out of it the same size as the auger hole, as shown in the diagram at *D*. It is surmised that these holes, and specially the last one to which we have referred, permitted the "etheric flow" of compressed air from the receiver in the cellar to the apparatus on exhibition to be controlled by a spring valve operated by the foot. Other holes seemed to have been located under the apparatus and doubtless aided in the experiments.

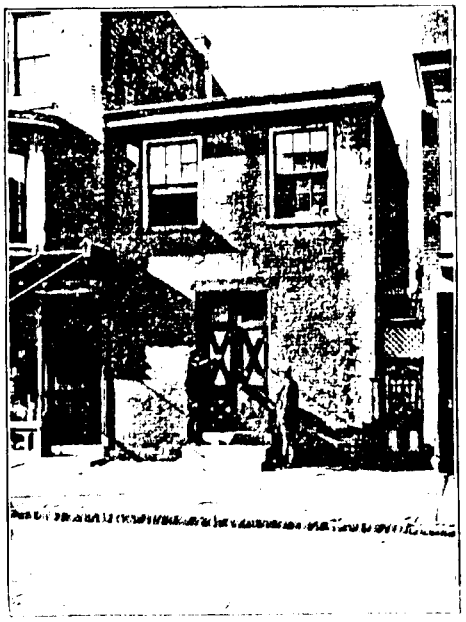


Tapped End of Sphere.

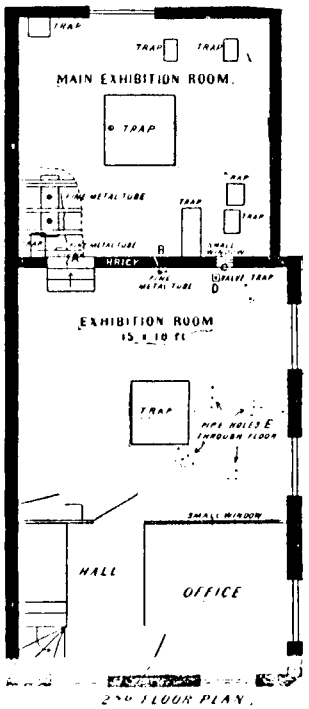
The upper floor of the main exhibition room was torn away during the investigation, and showed that tubing of the same kind as the alleged "wires" of Keely's lever machine passed under the joists, through the brick partition, under the threshold of the door at the point, *A*, connecting the two exhibition rooms. This is in a way the most remarkable of the find, as it was so carefully hidden in the brickwork, which had been removed and reset. The tubing ran through the brick partition under the steps, where it apparently descended into the room below, but this end was broken off. At the point, *B*, another piece of tubing was found running out into the front room from the rear room below. Those who assisted at the investigation were Prof. A. W. Goodspeed, Prof. Carl Hering, Dr. M. G. Miller, Mr. Moore and Mr. Sellers, and the investigations were so thorough and the results obtained were so satisfactory that it is to be hoped that, once for all, the Keely motor may be considered to be exposed, though we have no doubt that, like the scotched snake, the tail may still continue to wiggle.



Three-ton Sphere Discovered Under the Building.



Exterior of Keely Laboratory.



Plan of Second Floor of Laboratory.

Front Exhibition Room, Showing Trap, Pipe Holes, and Operating Window.

The Keely Motor: Genuine Or Hoax? Fantastic Or Flop?

Will We Ever Know?

Photos above, taken in the 1890's, show Keely and his globe-like "motors." His secrets, if valid, died with him before the turn of the century.

FEW people today have ever heard of John Worrell Keely and his fascinating "motor," but during the 26 years between 1872 and 1898 both business and scientific establishments were drawn into prolonged controversy because of his claims.

The Keely motor is as much an enigma today as it was a century ago. The jury is still out, and may never reach a verdict; but the Keely case offers insights into the intricasies of inventiveness and skeptical dogma like no other.

Financiers and scientists of his day either raved about the man and his motor, or they raged that he was a magnificent hoaxer.

What Keely demonstrated was the potential power in certain vibratory rates. For example one device demonstrated the movement of weight by striking the strings of a zither; another device indicated tremendous power generation by simply pouring a quart of water into a cylinder where tuning forks "liberated" energy inherent in the molecules of water.

He fired a small cannon with this same mysterious force that he claimed to be harnessing.

One account of his demonstrations read as follows:

"Mr. Keely was able to produce, under the close inspection of qualified and critical observers, a dynamic result which none of the witnesses pretended to account for by any known law of physics, outside of (Vibratory physics) which Mr. Keely claims as the base of his operation.

"He evolved, almost instantaneously, according to the united report of those who were present, a substance having an elastic energy varying from 10,000 to 20,000 pounds per square inch, and instantly discharged or liberated it into the atmosphere, without the evolution of heat in its production, or of cold on its sudden liberation."

Was Keely entering the age of atomic fusion and fission nearly 100 years ahead of his time?

If indeed he had a worthy secret and his demonstrations were valid – his knowledge died with him.

The vast majority of thinking following his death finally agreed that he must have used "air pressure" to trick his backers into financing him. This was a "comfortable" concensus explanation to accept.

However, the investigation into Keely's claims immediately following his death certainly did not prove that he was duping everyone who supported him. In fact the evidence for such a charge was flimsy at best.

Keely's claims were couched in phrases that had meaning only for him – at least that is how his detractor's saw it. He referred to such things as "etheric disintegration," or "molecular vibration," or "oscillation of the atom," or "sympathetic equilibrium," when he explained his power source.

There are some people today who would nod with seeming wisdom at such phrases and agree that Keely "must have been on the verge of some amazing new technology."

However, the generally well-educated physicist or engineer today shakes his head in seeming wisdom and conveys a message that says very clearly – "kook!"

Were it not for some other inventor stories within the pages of this publication the Keely matter might best have been left in the closet.

But, Dr. Thomas Henry Moray did indeed generate useful electric power from an apparent invisible "vibratory" source (see pages 41 - 43) and the late Karl Schaeffer most certainly developed a device that obtains energy from the "molecules" of water by shaking, chocking and vibrating it (see pages 11 - 13).

And, today's particle physicists will raise an eyebrow and tell you that "there just might be something to this

ancient mystical notion of ethers after all."

Our science is indeed wonderful, but it does have its limits -- though there are those who don't like to admit it.

On November 10, 1874 in Philadelphia, Keely exhibited his "vibratory generator," for the first time.

The inventor was a magnificent speaker and his charismatic powers attracted fanatical and well-healed backers.

His most generous supporter was Mrs. Bloomfield Moore, who inherited vast sums from her husband -- Edmund Moore. She supplied the majority of the capital that sustained the "Keely Motor Company."

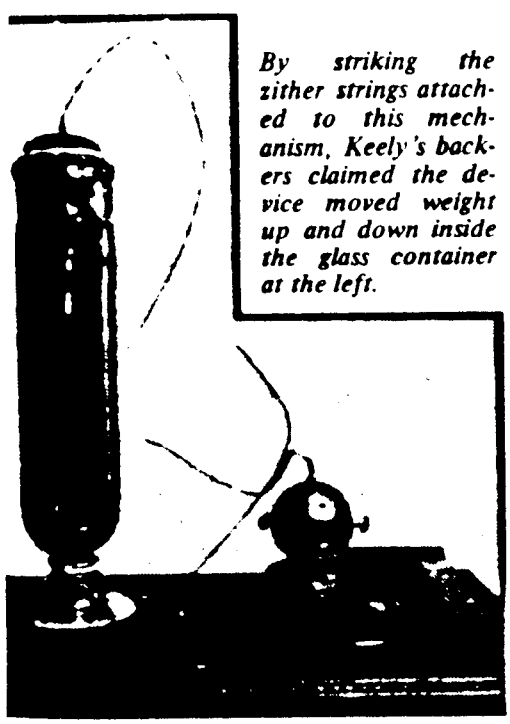
Her son, Clarence R. Moore was perhaps Keely's biggest detractor; he despised the "waste of money." It was Clarence who led the party of detractors to tear up the floor under Keely's apartment the day after the inventor's death.

Many of Keely's demonstrations took place in that apartment and beneath the floor the investigators found a huge metal globe filled with brass tubing. Holes had been drilled in the floor joists to allow tubing to pass through -- the conclusion was that Keely used air pressure to accomplish his "unexplained power" demonstrations.

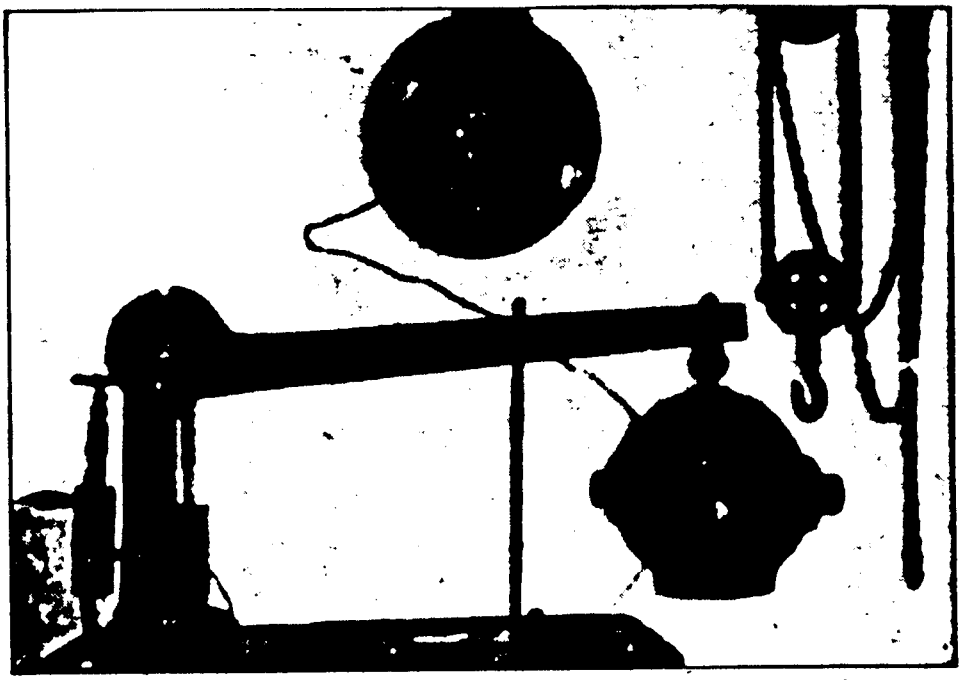
However, no compressor was found and at no time during any of his demonstrations did anyone hear the unmistakable sound of pneumatics in action.

Keely's backers said they knew of the hidden sphere and that it was used as a "vibratory chamber."

Mrs. Moore was no fool. She wrote a book, "Keely and his Discoveries," which showed the woman had an excellent mind and apparently understood better than most what it was Keely was attempting to demonstrate. If the universe was indeed "vibratory" in nature as many believed -- and still believe -- then certain "harmonics" might be the key to harnessing this vibratory nature as a power source.



By striking the zither strings attached to this mechanism, Keely's backers claimed the device moved weight up and down inside the glass container at the left.



Keely's backers claimed they witnessed his machinery in action and it was truly amazing. Above is the likeness of his "Disintegrator" designed to utilize the tremendous forces released when vibrations disintegrated molecules of water. The ball on the end of the lever has "550 lbs." written on it.

The idea is not the least "unscientific" as the lady pointed out so deftly in her book; she quoted Sir Isaac Newton:

"It is well known that bodies act upon one another by the attractions of gravity, magnetism and electricity; and these instances show the tenour and course of nature, and make it not improbable that there may be more powers of attraction than these. For nature is very consonant and comfortable to herself."

Mrs. Moore continues: "With such intimations of the hidden force that is ever in operation behind the framework of nature, shall we, because it is hidden from science, refuse to listen to the explanations which Mr. Keely is now prepared to give?"

Her book was written long before the atomic age successfully split unseen particles, but the well-read woman foreshadowed the coming of the new age -- again showing remarkable acumen and self-education:

"Sir Henry Roscoe says: 'The structure of the smallest particle, invisible even to our most searching vision, may be as complicated as that of any of the heavenly bodies which circle around our sun.' If you admit this, as stated by one of your own orthodox scientists, why refuse to admit the possibility of the subdivision of all corpuscles of matter, which Keely declares can be done by certain orders of vibration, thus showing up new elements?

"I do not ask endorsement of Keely's theories; but if physicists did not think it possible to rupture the atom, would they be calculating the chances of doing so, as Professor Fitzgerald has done?"

Mrs. Moore admitted she had no scientific credentials, but stressed that she read with understanding many books on the subject. She, like many thinkers today, attacked entrenched scientific dogma and scoffed at the academicians who had scoffed at Keely:

"Again, as to the canons of science, which are proved by Mr. Keely's researches to be erroneous: take the one which teaches that molecular aggregation is ever attended with dissipation of energy. From whence, then, comes the immense force which is liberated from the constituents of gunpowder by its exciter, fire? -- which is a certain order of vibration.

"Concussion, another order of vibration, releases the hidden energy stored in the molecules of dynamite, which tears the socks asunder as if they were egg-shells. Still another order of vibration, which Keely has discovered, dissociates the supposed elements of water, releasing from its corpuscular embrace almost immeasurable volumes

of the existing order of things ... "

The writer of this article, one Julius Moritzen, described one of Keely's "motors" as follows:

"A peculiar feature of the 'liberator' was a series of tuning forks with the vibrations of which Keely claimed to disintegrate air and release the etheric force capable of rivaling a cyclone in strength if properly utilized and applied ... "

That journalist Moritzen believed Keely had little more than charisma is evident from his description of a Keely presentation:

"It was almost worth the price of falling victim to hear Keely at the time theorize, expostulate where it became necessary, and survey his audience with one of those superior glances which meant to illustrate that he half pitied those who failed to understand his vocabulary.

"In one respect he was quite scientific in his procedure of explanation and in other respects he was quite the reverse."

Keely, like many of today's non-establishment inventors, kept the principles behind his discoveries totally to himself. There seems to be something in the personalities of these unusual thinkers that makes them almost paranoid when it comes to divulging their "secrets."

Keely, seated, is surrounded by members of the board of directors of the ill-fated Keely Motor Company. Photo was taken in the 1880's.

Dr. Moray died without clarifying what it was he had done to generate power from the radiant energy; Guido Franch vows to die without ever divulging the secret of his demonstrations of turning water into fuel. Both men were totally paranoid about the "establishment" getting their secret, then tossing them aside.

The apparent greed of big business doesn't necessarily instill confidence for the individual inventor. Of Keely it was said: "His excuse for not allowing anyone into his secret was based upon the commercial value, which he claimed he desired to have unimpaired for the benefit of the stockholders.

"It surely would not do to reveal a secret that might prove its own financial defeat" Moritzen surmised.

The skeptic could not understand the Keely followers. Moritzen writes:

"The personality of John Worrell Keely was replete with the charm of heartiness. His was the secret of the promoter's art. He had the insight necessary to the man of affairs, minus that quality of subjection which tells it is time to cease before it is too late. And when considered in this connection, that no one was ever taken into his confidence, it still remains a mystery how his following continued almost the identical one that stood by him from the conception of the scheme to his death and after."

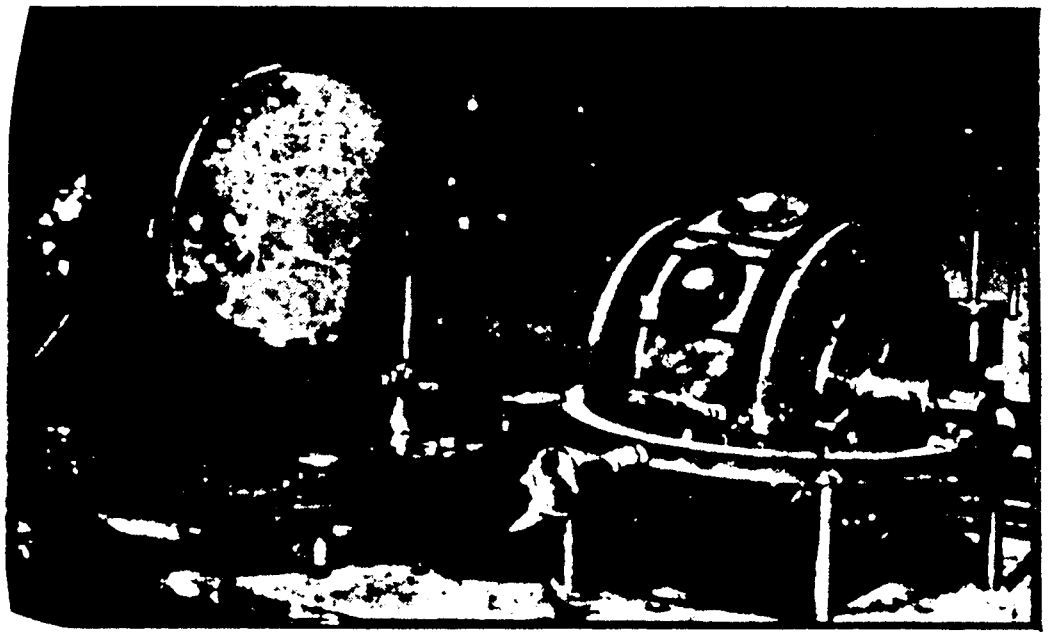
Moritzen's article clearly conveyed that the entire Keely episode was a "scheme." His personality evidently paralleled that of Preston Tucker who produced the amazing car bearing his name (see pages 29 - 31) and he too was a master promoter.

But personality plays no role in technology and science; so why is it always brought to the fore by detractors of a new idea? A man can be a pompous ass and still produce a fantastic invention.

Of course we can't say with any certainty that Keely was wrongfully judged and his inventions indeed worked; such a claim is unproven.

Keely and his discoveries were swallowed by time, but the message inherent in his story lives on -- although we may grow to think we've learned it all, there is always something new, something greater beyond our framework of understanding and we should approach new ideas with honest curiousity and not immediate negative skepticism.

The huge globe motor and dynamo which Keely backers assumed would "power the world." Modern technology might well benefit from a total investigation into Keely's claims simply because todays science is more aware of "hidden" potential in nature.



PERPETUAL MOTION MACHINES

by Stanley W. Angrist

Scientific American. p.114-122.

Perhaps the most ingenious, and certainly the longest-lived, swindle involving a supposed perpetual motion machine began in 1875, when John E. W. Keely unveiled a combined "generator" and engine at his home in Philadelphia. There was nothing unusual about Keely's engine, which was a variation on the conventional steam engine. Keely's generator, however, was extraordinary. It was an elaborate combination of metal globes, tubes, petcocks, nozzles, valves and gauges, but its operation was deceptively simple. Keely would blow into a nozzle for half a minute and then pour five gallons of tap water into the generator through the same nozzle. After turning various petcocks and valves he would show onlookers a pressure gauge indicating that the generator was full of a mysterious "vapor" with a pressure of 10,000 pounds per square inch. "People have no idea of the power in water," Keely would say. "A bucket of water has enough of this vapor to produce a power sufficient to move the world out of its course."

Keely and his associates formed the Keely Motor Company, capitalized at $1 million. They raised much of the money from gullible New York businessmen. As the years passed, although no engines other than the first one were ever built, Keely's showmanship became more polished. By 1881 he had begun to attribute the production of vapor to "vibratory energy," and he would "vivify" the vapor during demonstrations with a giant tuning fork. By 1884 he had so mastered what he now called the "etheric vapor" or the "interatomic ether" that he demonstrated a new device: a cannon, complete with a "vibrator" near the breech, that was capable of propelling a ball 500 yards with a muzzle velocity of 500 feet per second.

Keely died in 1898. The son of one of his major backers promptly rented his Philadelphia house and explored the premises in the company of reputable witnesses, seeking evidence of fraud. Under the floor of the house the searchers found a three-ton metal tank that had evidently served as a reservoir for compressed air. In the walls were found quantities of brass tubing, and a false ceiling suggested the means by which Keely and his associates had conducted the compressed air to his generator. Whatever other laws he may have broken in his long career, Keely had left the first and second laws of thermodynamics inviolate.

January 1968, Vol. 218.

Stranger then Science. Frank Edwards. (NY: Lyle Stuart, 1959). p. 157-159.

John Keely's Mystery Motor

The powerful engine shook the building . . . but it shook the existing understanding of energy even harder.

Twenty-three men were crowded into the same small room which housed the controversial motor. Many of them were engineers, others were professional men or bankers—and all of them were investors. They were skeptics, too; and they had waited years for John Keely to make good on his claims. Time after time they had poured their money into his endless research and profitless development of the engine that now stood before them. Today he had promised them that he would show what it could do. Was he fraud or genius? They should soon know.

John Keely never even glanced at the hard faces of the men who were packed into the room with him and his engine. If he was aware of their presence he gave no hint—just as he apparently ignored the ear-shattering noise that was rattling the small window panes. From the heavy steel machine, bolted to the massive stone base, came the screech of metal in travail. A deep hum changed to a moan—the moan to a whine. Wilder danced the window frames—as though they were eager to flee this unearthly din.

Keely knew he was master of the situation, because he, and he alone, was master of the machine before them. These irate investors were demanding proof that their money had gone

into something practical? Very well—they would soon have their proof! He lightly tapped a button, and the roar jarred the bones of every man present.

When the faint blue fog cleared away, the committee members could see that the one-inch lead ball had been expelled from the machine with such incredible force that it had shot completely through two heavy oak planks and buried itself in a sandbox against the wall.

Most impressive, the committee agreed; but when could they expect to put this latent power to work in a fashion that would reimburse the stockholders?

For John Keely this session with the stockholders' committee in November 1879 was an old, old story. He gave them performance—they insisted on profits. Over and over again, as the stockholders came and went, he endured their criticism and calumny. Through the years of ambivalence that surged about him, John Keely never lost his temper. Neither did he lose his ability to find new financial backers to replace those who had given and gone.

For a mechanical inventive genius, John had an unusual background. Born in Philadelphia in 1827, he worked as a carpenter, a violinist, a magician who specialized in card tricks; and finally he trudged to the Rocky Mountains as a trapper. Badly wounded by an Indian arrow, he made his way back to Philadelphia and eventually recovered from the wound.

It was an age when the need for controllable power was great. Water power could not meet the demands of growing industry. Steam power was not the answer—there must be some new cheap source of energy that could be harnessed to turn the wheels of the mills and factories.

John Keely first attracted attention by announcing, in 1871, that he had tapped a great new source of energy—as he put it with exasperating vagueness—"a device which disintegrates the etheric force that controls the atomic constitution of matter." Some scientists challenged him, some ignored him—all were skeptical of him.

Keely claimed that his engine operated on "harmonic vibrations." His detractors promptly retorted that the motivating force was hot air, generated by Mr. Keely. Whatever it was, it had enough power to bend steel rails and to tear giant hawsers into shreds, a force beyond anything in common use at the time.

In December, 1882, the angry investors demanded a showdown . . . and got it. Keely agreed to reveal the secret of his mystery motor to any scientist the committee named. They selected Edward Bakel . . . who saw and was convinced. He reported to the unhappy investors that, while he did not understand all that he had seen, he understood enough to know that Keely had discovered all he had claimed.

Keely's luck ran out in 1888, and the stockholders had him sent to jail for ignoring a court order to reveal his secret. A wealthy widow financed him for the next ten years, to the end of his life in 1898. The stockholders wrecked his shop, finally came upon a huge steel ball which contained compressed air. There was nothing new about that; for Keely had often shown the sphere to interested parties, and its pipes were inadequate to have operated at the pressures indicated by the performance of the machine.

The secret of Keely's mystery motor died with him. Scientists could never agree on how it had operated. The witnesses agreed on only one thing; the engine made a humming sound. The question remains: Were they hearing the birth pangs of a great discovery . . . or merely the persuasive hum of a humbug?

Tesla '86. Vol. 2, no. 4. August 1, 1986.
p. 29, 35. (International Tesla Society).

TESLA'S PEERS & PREDECESSORS

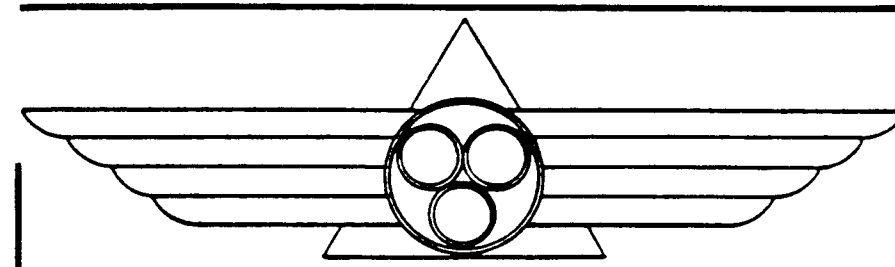
JOHN ERNST WORRELL KEELY
(1827-1898)

by Dale Pond

Founder of the Keely Motor Company of Philadelphia in 1874 and originator of the field of study known as Sympathetic Vibratory Physics. Mr. Keely spent his lifetime investigating what could be termed "applied quantum physics". He developed nuclear and atomic energies, ultrasonic motors and a host of related tools, machines and technologies. In his efforts to develop a motor, he designed and built 129 successive models before attaining success.

Grandson of the German composer, Ernst, John Keely had a good background in music. His later discoveries made extensive use of musical theory as applied to vibratory physics or quantum physics. His efforts in these fields pass far beyond the science of his day. Microwave and ultrasonic technologies weren't used by conventional science until the mid 1900s. His own descriptions of his theories and discoveries indicate he worked with atomic and nuclear energies decades before such forces were even recognized. His claims of using acoustic forces for levitating objects can now be verified through parallel work done by NASA in their technical reports describing their current work with acoustic levitation.

Edison, Hertz, Dewar and other contemporaries were mystified by Keely's works and took a wait and see attitude about his discoveries. Others, not so kind, blasted Keely with accusations of fraud. History will show the truth behind Keely's work.



Sympathetic Vibratory Physics

The forgotten physics of the Tesla era is explained in depth by many serious and down-to-earth researchers through this monthly journal.

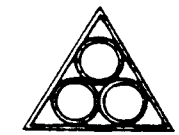
A no-nonsense approach to uncomplicate the "New Age Physics" or para-physics, expanding the existing paradgim to encompass nuclear, acoustic, electrical, and mental physics.

Perhaps one of the greatest scientific discoverers of all time, John Ernst Worrell Keely (1827-1898) made discoveries so in advance of the science of that era that we are only now beginning to understand them.

This journal is devoted to the elucidation of his many discoveries and includes articles related to the many fields now properly under study.

Keely is credited with:

Discovery of over 40 fundamental laws of physics
Creation of frequencies in the giga-hertz range
Control of the primeval substance--ether
Acoustic levitation, and its control
100,000 lb/sq-in pressures
Nuclear energy evolvement
Molecular disintegration
50-inch vacuums
Ultrasonics
Transmutation of elements
Mind energy control
Acoustical motors
Microwaves



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The Plenum. Vol. 1, no. 1. July/August 1989.
(Vanguard Sciences).

Report on the 2ND Int'l Keely Symposium

In the latter part of May, a group of about 75 people interested in the works of John W. Keely, met in Colorado Springs for the 2ND International Keely Symposium.

The primary topic of the Symposium was the discussion of the science of Sympathetic Vibratory Physics as developed by John Keely in the late 1900's.

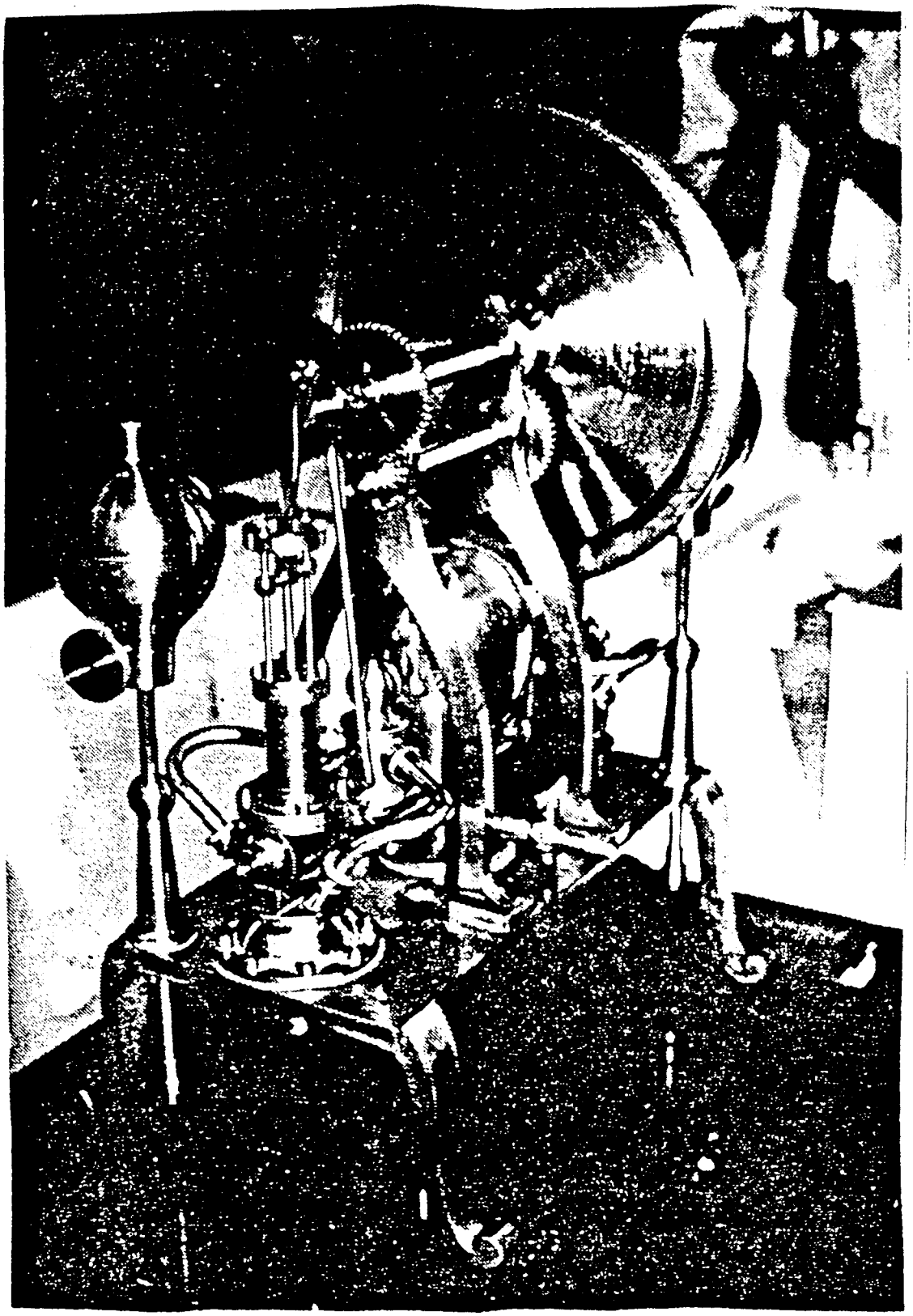
The main draw of this years Symposium was one of the original Keely Hydro-Pneumatic-Pulsating-Vacuo Engines and which was purchased from the Franklin Institute by Mr. Victor Hansen of Iowa. This device was in museum condition and **was designed** to operate on Thermodynamic principles which take advantage of the temperature difference of water as it changes phase.

This is one of the first models which Keely made and was based on simple observations relating to heat as evolved from compression and cold as evolved from vacuum. The original engine exploded after operating for a short time. The explosion was totally unexpected and led Keely on his subsequent quest for the causes. Later analysis led to duplication of the phenomenon under controlled conditions.

Keely found that a certain "order of vibration" would force the hydrogen and oxygen bonds to dissolve for an explosive dissociation of the water molecule. From this simple experiment, Keely went through hundreds of other experiments which yielded the amazing array of phenomena recorded in numerous articles spanning the period of 1872 through 1898.

Among the many interesting attendees was speaker John Tucker of Kansas. Mr. and Mrs. Tucker had attended our first Symposium in Dallas in 1987. They have been working with the Tesla concepts relating to the vast reservoir of electrical energy in the atmosphere of the planet. As a result, they have designed and built a free energy device which draws a limited amount of power from these atmospheric electric potentials.

Photos of the Conference and the Tucker device appear later in this issue of the Plenum.



A model of Keely's Original
Hydro-Pneumatic-Pulsating-Vacuo-Engine
based on modern thermodynamic principles,
yet built in the mid to late 1800's.

Mr. E. E. Richards spoke on the work of Tesla and his research into spectral analysis of the Schumann Resonances of the earths atmospheric cavity. (Researchers of Tesla must be aware that the true earth frequency as used by Tesla is 150 KHZ. We have recently come across a more precise frequency of 149.8 KHZ. – VANGARD) Mr. Richards recounted some of his experiments with long wire antennas and provided a real-time display of a Spectral Analysis system based on an IBM-PC. The system is manufactured by Rapid-Tech Systems and clearly showed the Schumann peak of 7.8, etc. with appropriate filtering of the 60 HZ component. Another beautiful analytical device which could be of use when studying a range of frequencies.

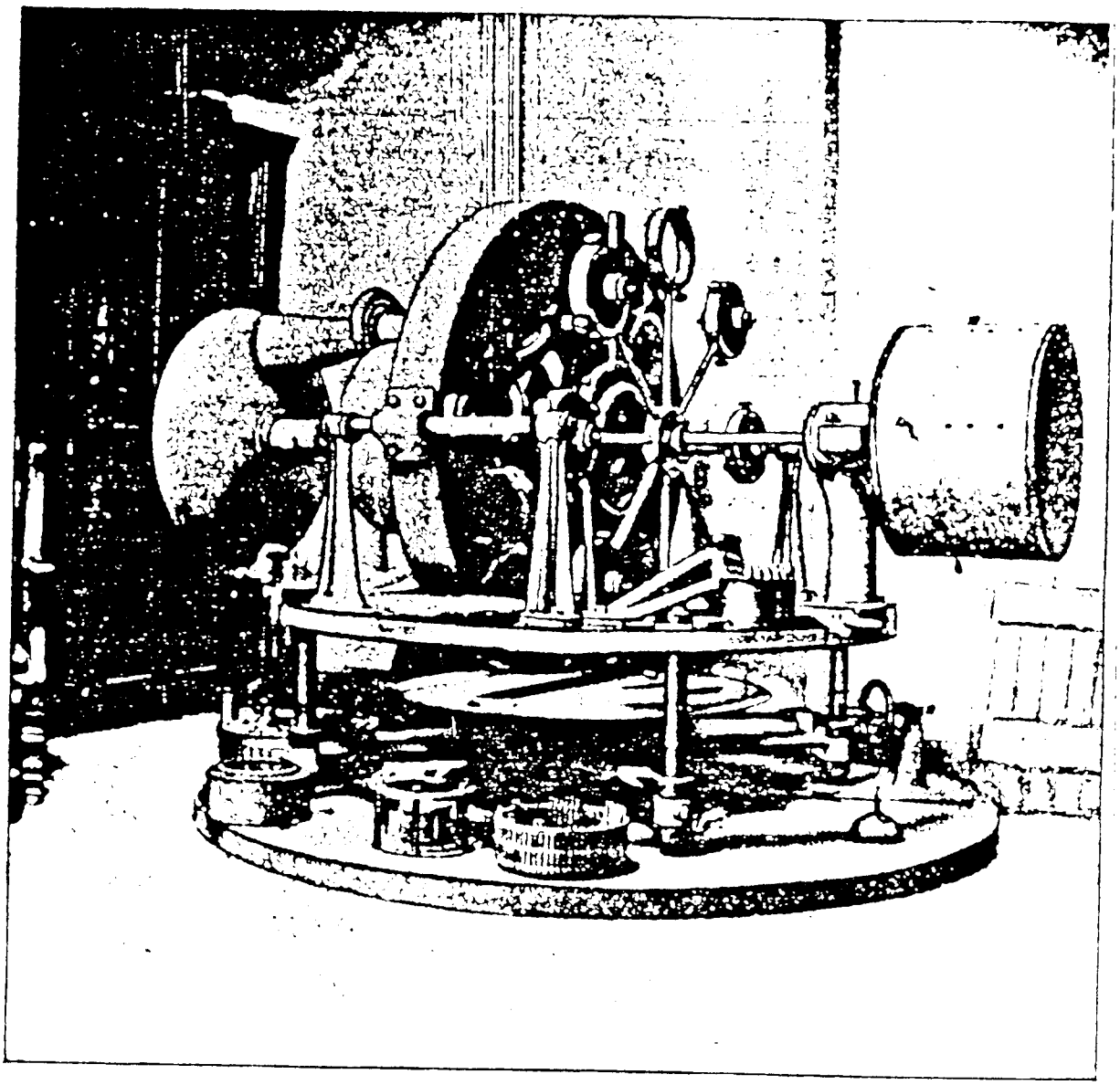
Dale Pond, editor of the Keely Journal of Sympathetic Vibratory Physics and organizer of this years Symposium gave a talk on the work of Keely. Dale is constructing a working model of the famous Musical Globe which Keely demonstrated at the World's Fair which was held in Philadelphia in the late 1800's. The device is designed to entrain cosmic energies to generate a spin which in turn generates music. No power is applied from an external source, once the device is tuned, it continues to spin until intentionally stopped. Dale had his model on display although it is non-functional at this time.

The conference was held at the beautiful Red Lion Inn at the base of NORAD Command Center in Colorado Springs. Scant miles from the location of Tesla's 1899 experiments.

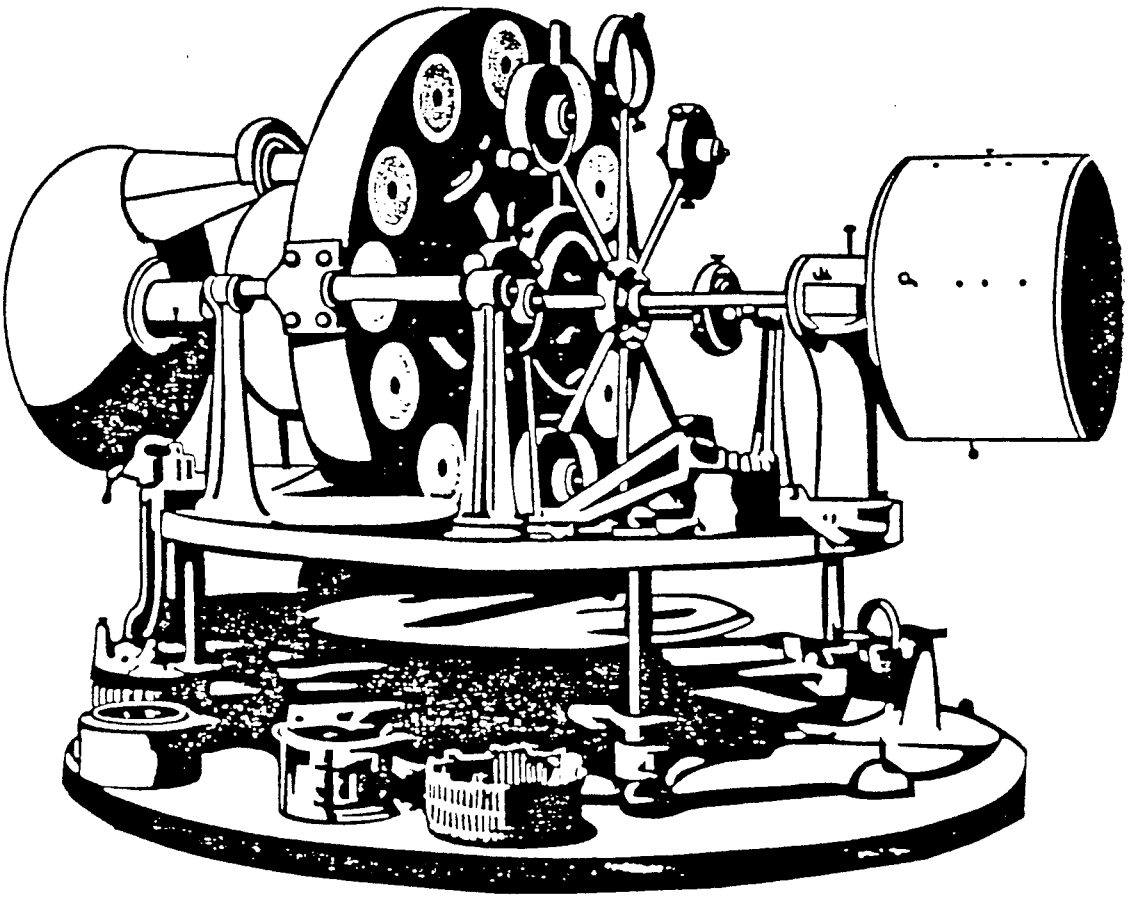
Extra Conference Tidbits...

We were given a drawing of the infamous Keely Aerial Propeller along with a chapter which was conspicuously removed from the Bloomfield-Moore book on Keely which concerns this device. Keely is supposed to have used his kitchen chair as a seat while flying the device around his neighborhood from 1893 on. It appears that the book was severely edited of certain information sometime after its publication in the early 1900's. By whom? Who knows, persons or groups who want the secrets to remain so or who have baser motives or simply wish to "protect" humanity from their own destructive natures.

In addition, to the description and picture of the device, we received a copy of all 40 of Keelys laws which detail the results of his experiments with compound frequencies. We will list all of this material on our BBS for downloading by all interested parties. This information came to us from a new contact who has the welfare of everyone at heart. He knows of whom we speak and we are eternally grateful for his sharing and openness.



John W. Keely's
AERIAL PROPELLER
built and flown successfully in 1893.
Demonstrated to the US War Department in 1896.
The AIRSHIP used vibration as
a source of levitation and propulsion.
It had in excess of 2000 parts,
none of which moved.
(Photo-copy courtesy of Mr. Victor Hansen)



A Graphic of Keely's Airship

Professor Henri Hertz said of Keely ;

"No man who is working on these lines, with SUCH INSTRUMENTS, is a fraud. I cannot help him; no one can help him; HE MUST WORK OUT THIS SYSTEM ALONE, and when it is completed, we can pursue our researches on the same lines. I thought Keely was working, as I am, with an electrical machine and wires. I HAD NO IDEA OF THESE WONDERFUL INSTRUMENTS."

Mrs. J. F HUGHES grandniece of Charles Darwin and researcher on sound and color sent Keely a copy of her book, "The Evolution of Tones and Colors", in which Keely found the following inspiration ;

"The LAW which DEVELOPS AND CONTROLS HARMONY, DEVELOPS AND CONTROLS THE UNIVERSE."

Notes on the Keely Airship

In this edition of the Plenum, we include a photocopy of an original drawing of the Keely Airship which was excised from the book "Aerial Navigation" by Bloomfield-Moore. Also included is a hyped-up graphic version which offers a clearer view.

One of the stories behind this device is alledged to have happened in 1896 when Mr. Keely demonstrated this flying machine to the press as well as the War Department (now known as the Department of Defense).

The space which the propeller of the airship occupies in Keely's laboratory comes within a radius of six feet square. A small space for so powerful a medium - distributing over 1000 horsepower, as tested by experiment. It consists of OVER 2000 pieces and weighed in excess of 1000 pounds.

A small stool was placed on the unit so that it faced a keyboard. Attached to the keyboard were many tuned resonation plates and vibratory mechanisms. Mr. Keely said that when the plates were polarized with "negative attraction" the airship would rise and float above the ground.

Keely could make the airship accelerate to any desired speed by damping out certain notes on the keyboard. The War Department demonstration took place in an open field where Keely brought the airship from zero to 500 MPH within seconds.

Keely was sitting on the stool and before the keyboard. There was nothing to shield him from the movement of the ship yet he seemed to suffer absolutely no acceleration effects.

The War Department was impressed, yet stated that they could see no use for such a complex device.

This version is from Dan A. Davidson's book "A Breakthrough to New Free Energy Sources". Dan has heavily researched Keely. There are many such stories regarding Keely which we are attempting to collect and re-distribute.

We felt the picture should be made available with a short description of what it does. The KeelyNet BBS will have the full document available for downloading soon. (214)-324-3501 ONLINE from Noon until 8 AM

Keely, John Ernst Worrell (b. Sept. 3, 1827—d. Nov. 18, 1898, Philadelphia), inventor of a fraudulent perpetual-motion system. Orphaned in early childhood, he is said to have been an orchestra leader, circus performer, and carpenter. From 1873 he exploited the popular interest in perpetual motion. He made a great show of guarding the secret of the motor he was developing to obtain power "from intermolecular vibrations of ether." Organizing the Keely Motor Company, Philadelphia, he sold stock to some 3,000 shareholders. After his death, examination of his apparatus showed that tubes of compressed air activated the machinery rather than the mysterious new force claimed by Keely.
·perpetual machine fraud 14:105b

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JUST SHOUT - AND IT'LL RAIN ---ON CHINESE MYSTERY LAKES! - Peking - Whenever residents in part of China's southern Yunnan province need rain ---- they simply yell for it. The LOUDER they yell, the MORE rain falls. And the LONGER they yell, the LONGER the rain lasts....The Liberation Daily reported that the local Communist Party boss shrugged off these reports but when he recently visited the lakes and shouted in a loud voice " a downpour followed in less than a minute". Local experts theorized the air around the lake was so wet that the slightest vibration such as a high - pitched voice could precipitate showers. **SOURCE: STAR - Ind, Ind. 2/24/81.**

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